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Development of High Level Electrical Stress Failure Threshold & Prediction Model for Small Scale Junction Integrated Circuits

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This report summarizes the experimental and theoretical work performed in order to develop engineering type prediction techniques to predict both surge impedances and failure levels of small scale junction integrated circuits when exposed to EMP type environments. A further requirement was that these predictive techniques should not require a "hands on" device evaluation but should relate the surge impedance and failure levels to some

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associated device parameter which could easily be obtained from a manufacturer's data sheet or other published information.

The data required to develop the models was obtained by a literature search of numerous DOD and NASA agencies and contractors. In addition, 252 integrated circuits were experimentally evaluated to determine their specific pulse response and damage characteristics. These 252 devices consisted of 11 individual part types, 7 digital part types and 4 linear part types. All pulse damage experiments were performed using unipolarity, single square wave pulses of 10 nanosecond to 1 microsecond duration.

Models were generated for the power failure threshold as a function of pulse width, the current failure threshold as a function of pulse width and the impedance as a function of current. The pulse current failure models and the current dependent impedance models that were developed represent the first such extensive formulations for integrated circuits. These models were generated for each significant category of integrated circuits for which data were available. The categories that were established included the following.

RTL Devices
DTL Devices
TTL Devices
Standard TTL Devices
Low Power TTL Devices
High Speed TTL Devices
Schottky TTL Devices
Low Power Schottky TTL Devices
Linear Devices
Operational Amplifiers
Comparators

The standard deviation of each model is given so that predictions of the failure level of an untested device can be made with any desired degree of confidence.

PREFACE

This Final Technical Report was prepared by the General Electric Company, Space Division, Philadelphia, Pennsylvania, under U.S. Army Contract DAAG39-76-C-0138. The work was administered under the direction of the U.S. Army, Harry Diamond Laboratories, Nuclear Engineering Branch 240, 2800 Powder Mill Road, Adelphi, Maryland 20783. Technical monitoring of the contract at USA/HDL was under the direction of Christian Fazi. The program manager at the General Electric Company was Dante Tasca and the principal investigator was Hugh O'Donnell.

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SUMMARY

The overall objective of this work was to develop engineering type prediction techniques to predict both surge impedances and failure levels of small scale junction integrated circuits when exposed to EMP type environments. A further requirement was that these predictive techniques should not require a "hands on" device evaluation but should relate the surge impedance and failure levels to some associated device parameter which could easily be obtained from a manufacturers data sheet or other published information.

A comprehensive literature search of numerous DOD and NASA agencies and contractors was utilized in order to uncover and obtain existing experimental pulse response and damage data for different integrated circuit part types. Since it was required to develop a prediction technique for pulse impedance, the data base was required to be defined down to the level of average voltage and average current associated with each experimental data point rather than down to just a pulse power-time definition. All experimental pulse response and damage data obtained from the literature search activity were reduced and stored in computer memory for subsequent computer aided analysis. In addition, the literature search was also used to uncover any existing predictive techniques and models that could be used to determine the failure thresholds of integrated circuits. These predictive techniques were evaluated in order to determine their validity, accuracy, and limitations.

The modeling effort was based on the extensive experimental data base obtained from the literature search and from the extensive tests that were performed on this program. The objective of these tests was to verify and provide additional data for the failure threshold tools and prediction techniques that were developed. Here "data base fill-in" tests for IC types which were incompletely characterized in the existing data base were performed. Also, "data base expansion" type testing was performed in order to provide enough data to establish meaningful models for different categories of ICs. Tests were also conducted in order to extend the data base to the shorter, 10 nanosecond, pulse widths and to examine some of the more recent IC families (i.e. Schottky TTL and low power Schottky TTL) in order to determine if these types of parts needed to be classified as a separate category or whether they were very similar to the regular TTL devices. The part tests on this program showed that the response of Schottky and low power Schottky TTL devices were indeed significantly different than the regular TTL.

In the present program, 252 integrated circuits were experimentally evaluated to determine their specific pulse

response and damage characteristics. These 252 devices consisted of 11 individual part types, 7 digital part types and 4 linear part types. All pulse damage experiments were performed using unipolarity, single square wave pulses of 10 nanosecond to 1 microsecond duration. All pulse power data (current and voltage) for the test units were obtained using an automated computer controlled test system. This system had the capability of automatically obtaining the data together with the proper test condition identification and serialization, processing it, and storing it on magnetic tape for batch reduction on the H6060 computer system. The principal components of the system were the Tektronix R7912 Transient Digitizers, a PDP 11/40 Computer and a Datum 7 Track Magnetic Tape System.

The modeling effort defined five major categories of integrated circuits (RTL, DTL, TTL, ECL, and LINEAR). For each of these categories, pulse damage models were formulated for both the average power to failure and the average current to failure for the input, output and power supply terminals. The pulse current failure models that were developed represent the first such extensive formulations for integrated circuits. In addition, an average impedance model was developed for each terminal in each category. Models were also developed for several classes of devices within two of the major categories. These additional classes included operational amplifiers, comparators, standard TTL, low power TTL, High speed TTL, Schottky and low power Schottky TTL types. Correlation analyses were also performed between the power failure threshold and the electrical parameters of the devices. The results showed the terminal capacitance to be the parameter that exhibited the most correlation with the power failure threshold. Other electrical parameters showed some correlation with the power failure threshold, however, these results were not systematic in that the other electrical parameters did not show good correlation across different categories. The electrical parameters that showed some correlation with the power failure threshold for some category terminals were the propagation delay time, power dissipation, breakdown voltage and the thermal resistance. Categorization of the devices into major categories resulted in better models than grouping all devices together and attempting to correlate their failure threshold with any combination of electrical parameters.

1) INTRODUCTION

This document is the Final Technical Report for U.S. Army, Harry Diamond Laboratories Contract DAAG39-76-C-0138, "Development of High Level Electrical Stress Failure Threshold and Prediction Model for Small Scale Junction Integrated Circuits". The overall objective of this work was to develop engineering type prediction techniques to predict both surge impedances and failure levels of small scale bipolar junction integrated circuits when exposed to EMP type environments. A further requirement was that these predictive techniques should not require a "hands on" device evaluation but should relate the surge impedance and failure levels to some associated device parameter which could easily be obtained from a manufacturers data sheet or other published information. This program consisted of four major tasks. The first task was to perform a comprehensive literature search to identify and obtain existing failure threshold data and predictive models. The second task was to evaluate the existing predictive techniques. The third task, on which the most emphasis was placed was to develop engineering type models to predict both the failure thresholds and the surge impedances of small scale bipolar integrated circuits. The last task was to conduct failure threshold tests on selected integrated circuits (ICs) in order to improve and verify the predictive techniques developed.

The objective of the Literature Search Task was to form a data base library of component failure data for small scale junction integrated circuits. Since it was required to develop a prediction technique for pulse impedance, the data base was required to be defined in terms of the average voltage and the average current associated with each experimental data point rather than down to just a pulse power-time definition. All experimental pulse response and damage data obtained from the literature search activity were reduced and stored in computer memory for subsequent computer aided analysis.

The Literature Search Task also uncovered the existing predictive techniques and models that could be utilized to determine the failure thresholds of ICs. These predictive techniques were evaluated in the Predictive Technique Task in order to determine their validity, accuracy and limitations.

The objective of the Model Development Task was to develop engineering type damage models to predict both surge impedances and failure thresholds of integrated circuits when exposed to EMP type environments. The approach taken in the model development program was as follows:

(1) existing pulse damage data on small scale

junction integrated circuits were obtained from a literature search of government agencies and their contractors and a computerized data base was constructed;

(2) the various published device specifications and construction type were defined for each unique device identification number and manufacturer combination in the data base;

(3) the published specification parameters which were common to all device types within certain functional classifications were identified;

(4) multiple regression analyses of the pulse damage data versus the common specification parameters within each functional classification were performed; and,

(5) the device parameters which correlated best to the experimental surge impedance and failure level values together with the prediction errors associated with each empirical model were then identified.

The objective of the Failure Threshold Test Task was to verify and to provide the additional data for existing failure threshold tools and prediction techniques that were developed. In addition, "data base fill-in" tests were performed on selected terminal pairs, selected pulse widths, and selected pulse polarities for IC types which were incompletely characterized in the existing data base. Tests were also conducted in order to extend the data base to 10 nanosecond pulse widths. Most of the presently available data is for pulse widths greater than or equal to 100 nanoseconds with the preponderance of data at 10 microseconds. Also, "data base expansion" type testing was performed to provide enough data to establish different categories of ICs. Some of the more recent IC milies (i.e. Schottky and low power Schottky TTL) were examined to determine if these IC types should be classified as a separate category or whether they were very similar to the regular TTL devices. Most of the presently available data are for pulse widths greater than or equal to 100 nanoseconds with the preponderance of data at 10 microseconds.

2) EVALUATION OF EXISTING FAILURE THRESHOLD PREDICTIVE TECHNIQUES FOR INTEGRATED CIRCUITS.

An assessment of the susceptibility of electronic systems to the effects of electromagnetic pulses (EMP) requires a knowledge of the electrical pulse damage thresholds for all of the components in the system. These damage thresholds may be determined either by test or by the use of models which predict the failure thresholds. Much has been done to develop failure models for discrete semiconductor devices. However, comparatively little has been done in the modeling of integrated circuit failure thresholds.

Vandre[1] modeled integrated circuit burnout by extending the single-junction pulse power burnout model developed by Wunsch and Bell for discrete devices to integrated circuits. The application of this model is as follows. First, the most vulnerable path and the most vulnerable junction in that path are determined. The area of this junction defines, through the use of the Wunsch-Bell curves, the critical amount of power that will cause failure. The junction breakdown voltage is either obtained from the specification sheet of the device or estimated. The bulk impedance of the entire path through the IC is then analytically determined. The terminal failure power can then be obtained by a simple[2] calculation. The Wunsch-Bell single junction burnout model calculates the pulsed power per unit area necessary to raise a semiconductor junction to the melting point of silicon. At this point, the junction is assumed to fail. A linear heat-flow model is used to obtain the following relation:

$$\frac{P}{A} = \sqrt{\pi K \rho C_P} \quad (Tm - Ti) \quad t^{-1/2}$$

where
P = power
A = junction area
K = thermal conductivity
p = the density
Cp= specific heat
Tm=failure temperature
Ti=initial temperature
t = time

Figure 1 shows a comparison of experimental data for discrete semiconductor devices and the theoretical power per

1. R. H. Vandre,"Pulse Power Burnout of Integrated Circuits". The Aerospace Corporation,TR-0073 (3124)-1 SAMSO-TR-226,Aug.1976
2. D. Wunsch and R. Bell,"Determination of Threshold Failure Levels of Semiconductor Diodes and Transistors Due to Pulsed Voltage",IEEE Trans. Nucl. Sci. NS-15 p.244 ,1968

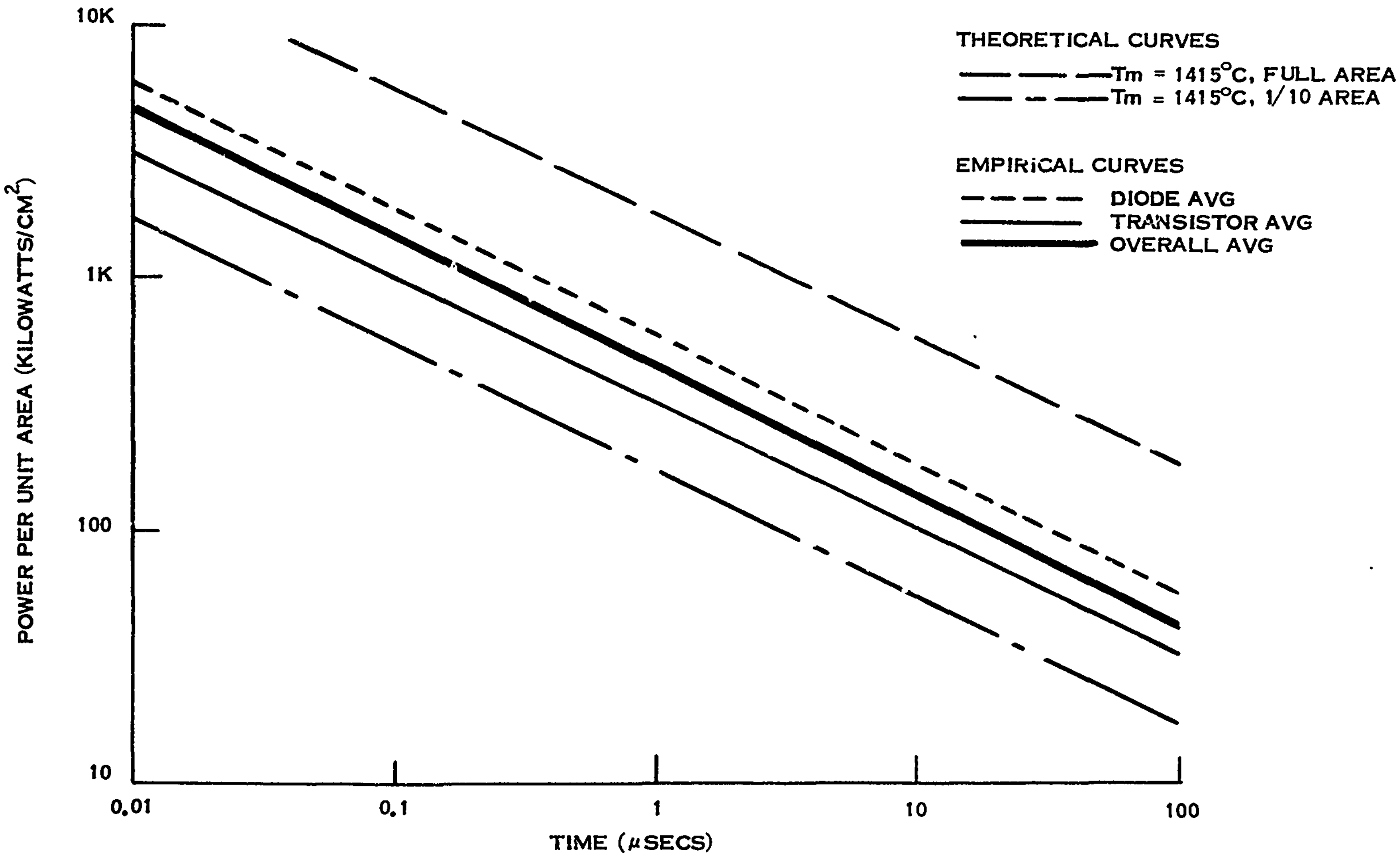


Figure 1. Semi-Empirical Failure Equations Obtained From Theory and Experimental Data Using the Wunsch-Bell Single Junction Model

unit area necessary to raise the temperature of silicon from room temperature to 1415 C from the Wunsch-Bell single junction model using one dimensional heat transfer theory. In order to obtain the failure level for a device it is also necessary to know the bulk impedance of that device. Once the junction area and the bulk impedance of a device are known it is generally straight forward to determine the power necessary to damage the device.

The difficulty in extending the single junction model to integrated circuits is that many of the physical parameters necessary for the calculation of the failure level are not readily available and must be obtained experimentally. The parameters that are needed are: the resistivity of the colector, the base sheet resistance, the depth of the buried layer, the buried layer sheet resistance, the depth of the emitter, the depth of the base and the junction areas. In addition, the most vulnerable path through the IC and the most vulnerable element in that path must be determined.

Vandre's model also assumes that all junctions are ideal and that the bulk impedance as calculated is equal to the bulk impedance at high injection levels. That is, it is assumed that there is no conductivity modulation at high injection levels as shown by Tasca.[3] Junction failure is the only failure mode addressed in this model. Metallization burnout, failures in the internal resistors of the device or the different vulnerabilities exhibited by different device technologies or processing differences are not modelled. The accuracy of this predictive technique was evaluated by comparing the predictions of the model with the average of Vandre's experimental results. This comparison shows the model to be good to within a factor of three (one sigma) in the prediction of the device power to failure. Table 1 shows the predicted versus actual power to failure for six device terminals. As shown in Table 1, the actual power to failure is about one third of the predicted power based on the total junction area of the most vulnerable junction.

All of Vandre's results described in Reference 1 are expressed in terms of the pulsed voltage to failure for a device. A comparison of the predicted and actual voltages to failure using this model for the Amelco 6041 Nand Gate is shown in Figure 2. Only the results shown in Table 1 were readily translatable from Reference 1 to power failure levels. Analysis of the predicted versus actual voltage to

1 R. H. Vandre, "Pulse Power Burnout of Integrated Circuits," The Aerospace Corporation, TR-0073(3124)-1, SAMSO-TR-226, Aug. 1976.

3. D. Tasca, S. Stokes, "EMP Response & Damage Modeling of Diodes,``, Junction Field Effect Transistors Damage Testing and Semiconductor Device Failure Analysis", GE. Doc. NO. 75SDS4279, Dec. 1975

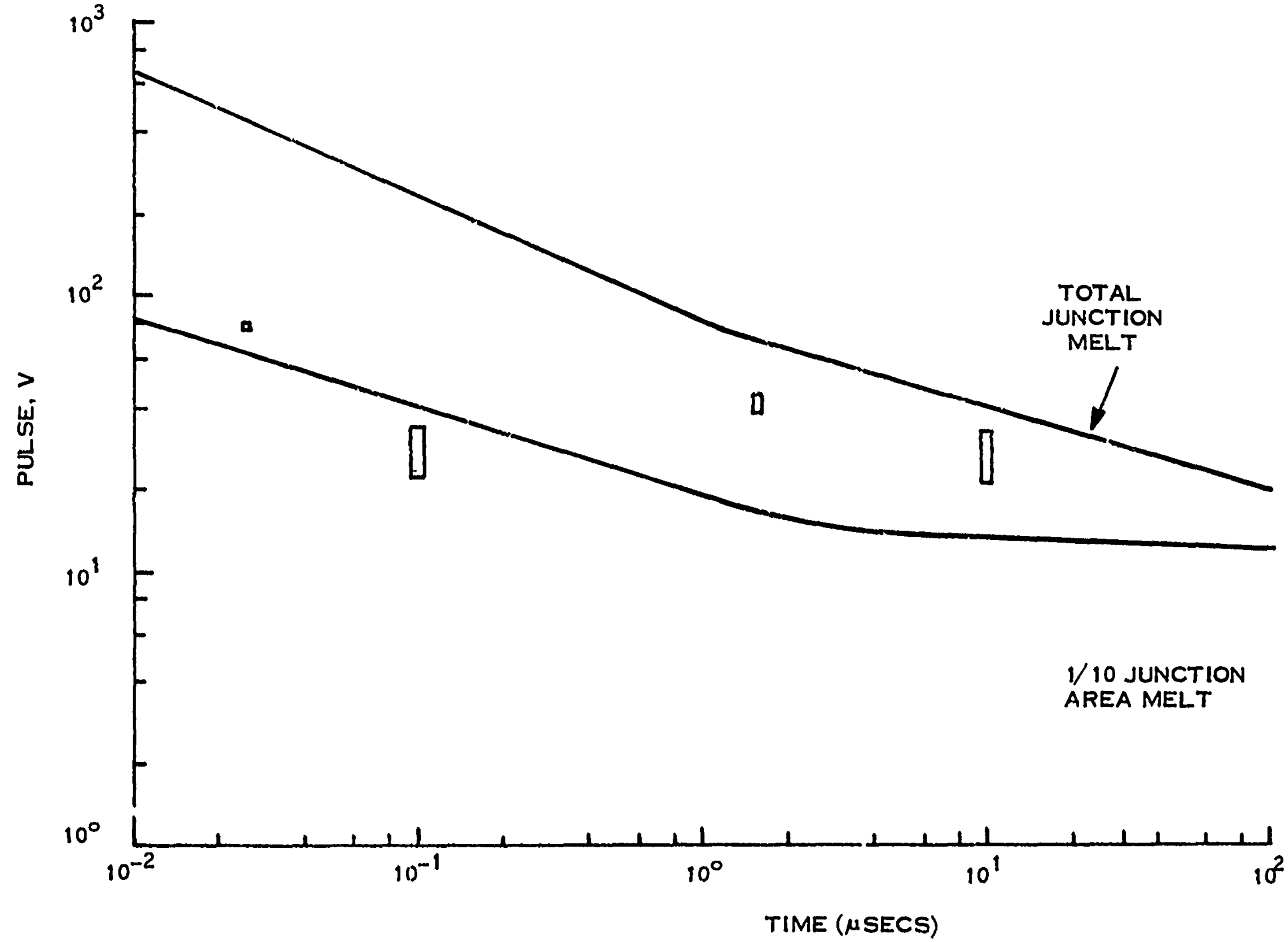


Figure 2. Comparison of Vandre's Model and Experimental Data for Amelco 6041 Nand Gate Output

Table 1

Predicted vs Actual Pulsed Power to Failure for
Two Integrated Circuits Using Vandre's Model

Device	Average Actual Power(w)	Predicted Power(w)
A[1]	115	200
A	55	126
A	40	100
A	20	40
B[2]	14	45
B	5.3	23.6

1 Fairchild 9046 Quad-Input Nand Gate Output terminal at pulse widths 25 ns to 640 ns

2 Acmelco 6041 Dual Three-Input Nand Gate input terminal at pulse widths of 25 ns and 100ns .

failure shows that almost all of the results are bounded by predictions based on the full junction area and one tenth of the junction area. Thus, this technique predicts the failure level in terms of voltage to witin about an order of magnitude.

The AWACS EMP Guidelines[4] presents two different models to predict the damage power of the device and the circuit damage EMP voltage (VEMP). Neither of these models account for any bulk impedance in the device or any of the conductivity modulation effects at high injection levels. The first model that is presented is the so-called "Know-Nothing Model". The application of this model is as follows.

> "In using this model nothing is known about the integrated circuit parameters. The following steps should be applied:
>
> 1. It must be determined from the circuit schematic that the device exhibits a PN junction failure and not another failure mechanism.
>
> 2. A damage constant of K=0.01 watt - $(sec)^{1/2}$ is used.
>
> 3. The typical breakdown voltage V_{BD} for an emitter-base junction is used, $V_{BD} = 7V$
>
> 4. Circuit impedances (Z) of non-semiconductor devices are determined.
>
> 5. The damage power at the PN junction is calculated as
>
> $$P = \frac{K}{\sqrt{t}} = I\,V_{BD}$$
>
> 6. The damage EMP voltage (VEMP) is calculated
>
> $$V_{EMP} = V_{BD} + IZ = V_{BD} + \frac{KZ}{V_{BD}\sqrt{t}}$$
>
> 7. The damage EMP voltage is calculated for collector-base junction breakdown, BV_{CBO} = 35V and for collector-emitter breakdown,

4. R. Carter, "Guidelines for Microcircuit Selection and Qualification - A Supplement to AWACS Guidelines for Parts Selection and Qualification", Boeing Aerospace Company, Oct. 1973

$$BV_{CEO} = BV_{CBO} / m\sqrt{B}$$

where B = current gain and m = 2, 4, for P-type and N-type silicon respectively."

Figure 3 is a display of predicted pulsed power to failure at 1 microsecond for the constant value of K=0.01 watt/(sec) assumed in this model and the experimental data taken on 6 technology families (i.e., TTL, RTL, DTL, ECL, MOS, and Linear). The model appears to be a conservative lower limit for most of the experimental data, however, it is clear that some devices have an even lower damage constant than the model predicts. On the other hand, for some terminals of some families of devices the model is more than a factor of ten lower than the data. Thus, if a universal damage constant is to be used which is lower than all of the observed data, then the value of 0.01 watt/(sec) is not sufficiently conservative and should be revised downward to about 0.003. This type of model is useful in the analysis of circuits where the qualification of that circuit does not greatly depend on the value of K. In those circuits where this model indicates additional hardening is needed, it is necessary to employ a more refined predictive technique to avoid a gross overhardening of that circuit because of the very large range (several orders of magnitude) of damage constants of the ICs.

The second model that is presented in the AWACS EMP Guidelines[4] is the so-called "Know-Something Model". The application of this model is as follows.

1. The circuit schematic of the integrated circuit is analyzed to determine which junction will be stressed and whether power dissipation in other components is important, e. g., thin film resistors.

2. The value of K is determined either from experimental data, or is calculated from manufacturer's information.

   a) Junction Capacitance Calculation

   If the breakdown voltage VBD of the junction under investigation and the junction capacitance (Cj) can be determined from the manufacturers's data, then K can be calculated for silicon planar construction.

$$K = 8 \times 10^{-6} \; C_J \; V_{BD}^{1.63}$$

4. R. Carter, "Guidelines for microcircuit Selection and Qualification - A Supplement to AWACS Guidelines for Parts Selection and Qualification," Boeing Aerospace Company, Oct. 1973.

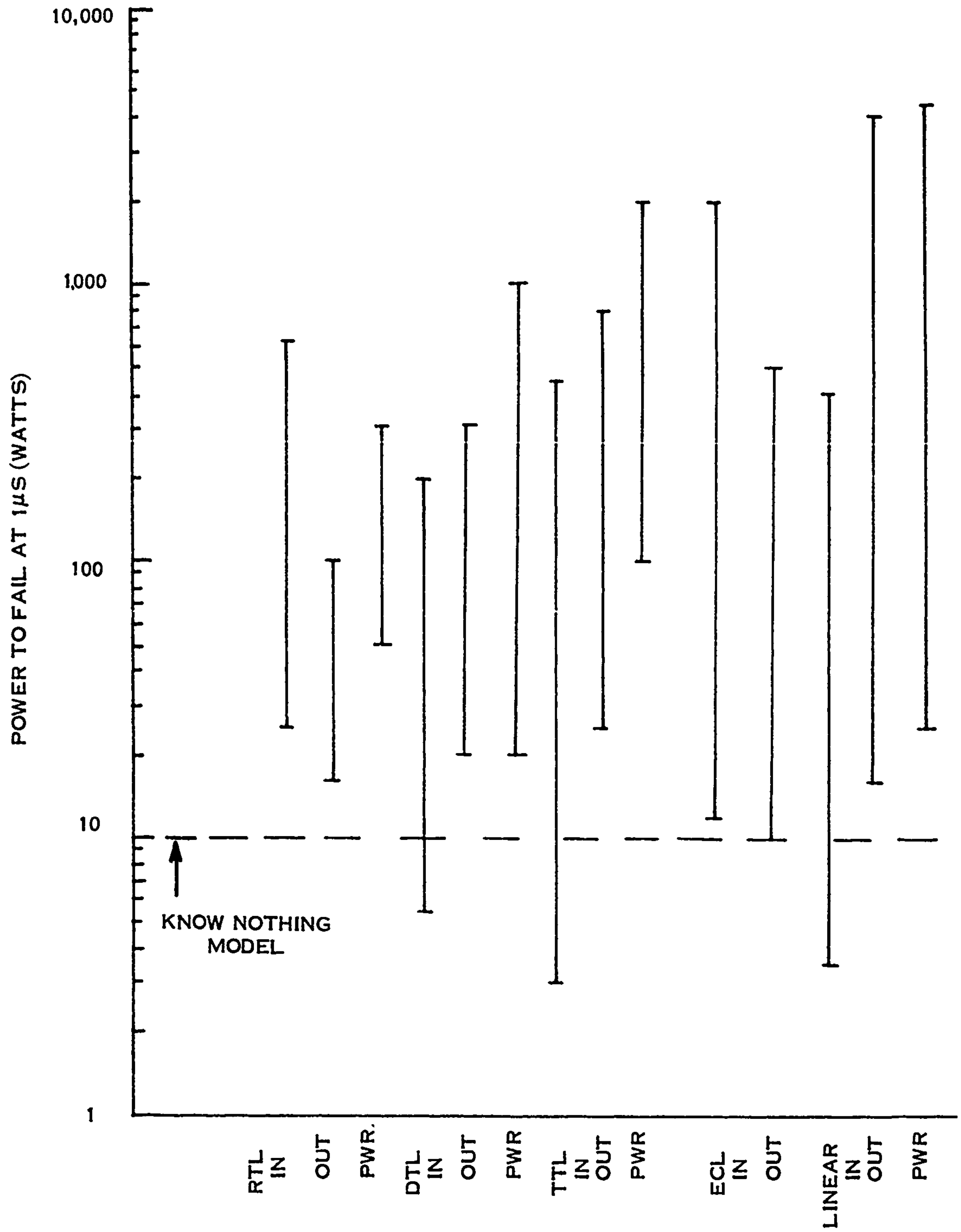


Figure 3. Comparison of the AWACS "Know Nothing Model" with the Failure Data in Several Categories of Integrated Circuits

b) Junction Area Calculations

When the junction geometry is sufficiently well-known, an estimate of the junction area (A) can be made. A value for the damage power P can then be obtained from the P/A silicon curves shown in Figure 1. The 1/10 area curve should be used for a worst case analysis.

3. The breakdown voltage for the junction being stressed is determined from manufacturer's data.

4. Steps 4-7 discussed in the "Know Nothing Model" are used to complete the analysis.

The use of the junction area in the above model, or the use of the junction capacitance to approximate the junction area is the same technique that Vandre employed, except that he also calculated the bulk impedance. The difficulty with the junction area approach is that this parameter is not readily available and it is difficult to measure experimentally in an integrated circuit. According to the AWACS Guidelines this method yields results accurate to within a factor of 3 to 10 of experimental results depending on the construction of the device.

Jenkins and Durgin[5] also developed a failure threshold prediction methodology. Their methodology employs an experimentally determined failure model in order to calculate the failure power as a function of time for device categories based on the IC family (Transistor-Transistor Logic (TTL), Diode-Transistor Logic (DTL), Linear, etc.) and terminal tested (Input, Output, Power). This model is based on the expectation that the response of all devices from a single family to pulse voltage overstress should be of the same order of magnitude. This expectation is justified because all of the ICs within a given family have similar terminal characteristics. That is, the basic input topology is similar and the operating voltage levels are the same order of magnitude, indicating that internal parameters such as doping concentrations and device geometries are of the same order of magnitude. Failure models for sixteen of these categories have been defined as shown in Table 2. Each of these categories has an experimentally derived failure model of the following form:

$$P = A\,t^{-B}$$

5. C. Jenkins and D. Durgin, "EMP Susceptibility of Integrated Circuits", IEEE Trans. Nucl. Sci., NS-22, p.2494, 1975

Table 2
Failure Models for Sixteen Categories of Integrated Circuit Types and Terminal Pairs Developed by Jenkins and Durgin

No.	Category		$P = A\,t^{-B}$		$\bar{V}_B$	$\bar{R}_B$	Confidence Interval for A	
	Family	Terminal	A	B	(Volts)	(Ohms)	Lower 95%	Upper 95%
1	TTL	Input	0.00216	0.689	7	16	.00052	.00896
2		Output	0.00359	0.722	15	2.4	.00098	.013
3	RTL	Input	0.554	0.384	6	40	.12	2.6
4		Output	0.0594	0.508	5	18.9	.0090	.39
5		Power	0.0875	0.555	5	20.8	.026	.70
6	DTL	Input	0.0137	0.580	7	25.2	.0046	.041
7		Output	0.0040	0.706	1	15.8	.012	.136
8		Power	0.0393	0.576	1	30.6	.009	.17
9	ECL	Input	0.152	0.441	20	15.7	.045	.51
10		Output	0.0348	0.558	0.7	7.8	.0031	.397
11		Power	0.456	0.493	0.7	8.9	.22	.935
12	MOS	Input	0.0546	0.483	30	9.2	.0063	.47
13		Output	0.0014	0.819	0.6	11.6	.00042	.0046
14		Power	0.105	0.543	3	10.4	.038	.29
15	Linear	Input	0.0743	0.509	7	13.2	.0054	1.01
16		Output	0.0139	0.714	7	5.5	.0045	.043

where P = average failure power in watts
t = pulse width in seconds
A & B = empirically determined constants

In addition to the failure power model for each category, parameters analagous to the junction breakdown voltage, VB, and the bulk impedance, RB, are also given. The parameter, VB, was empirically determined and was found to vary by less than a factor of two within each category. The parameter RB, was computed at 1 microsecond from the average failure power and voltage. The basic device equivalent circuit associated with this failure model is shown in Figure 4. The failure voltages and currents predicted by this model are determined in the following manner using the parameters given in Table 2:

(1) Compute the failure power, P, at the pulse width of interest, t, using:

$$P = At^{-B}$$

(2) The damage current, I, and damage voltage, V, associated with the above calculated damage power, P, are then determined from

$$R_B I^2 + V_B I - P = 0$$

$$V = V_B + I R_B$$

For each of the categories "95% tolerance limits for a point estimate about the line"[6] were defined. Table 3 shows the mean value and the values of the 95% tolerance limits for a pulse time of one microsecond. As can be seen by examining Table 3, the range in failure power that is encompassed by the 95% tolerance limits often exceeds an order of magnitude and sometimes exceeds two orders of magnitude (ECL-Output and LINEAR-Input). According to Jenkins and Durgin,[5] even this model, which is the most elaborate, does not yield accurate predictions of the overstress response of untested ICs at a high confidence level. Rather this model yields order-of-magnitude predictions of the failure thresholds of untested ICs.

5. C. Jenkins and D. Durgin, "EMP Susceptibility of Integrated Circuits", IEEE Trans. Nucl. Sci. NS-22 p.2494, 1975

6. Alexander et al, "Electromagnetic susceptibility of Semiconductor Components" AFWL-TR-74-280

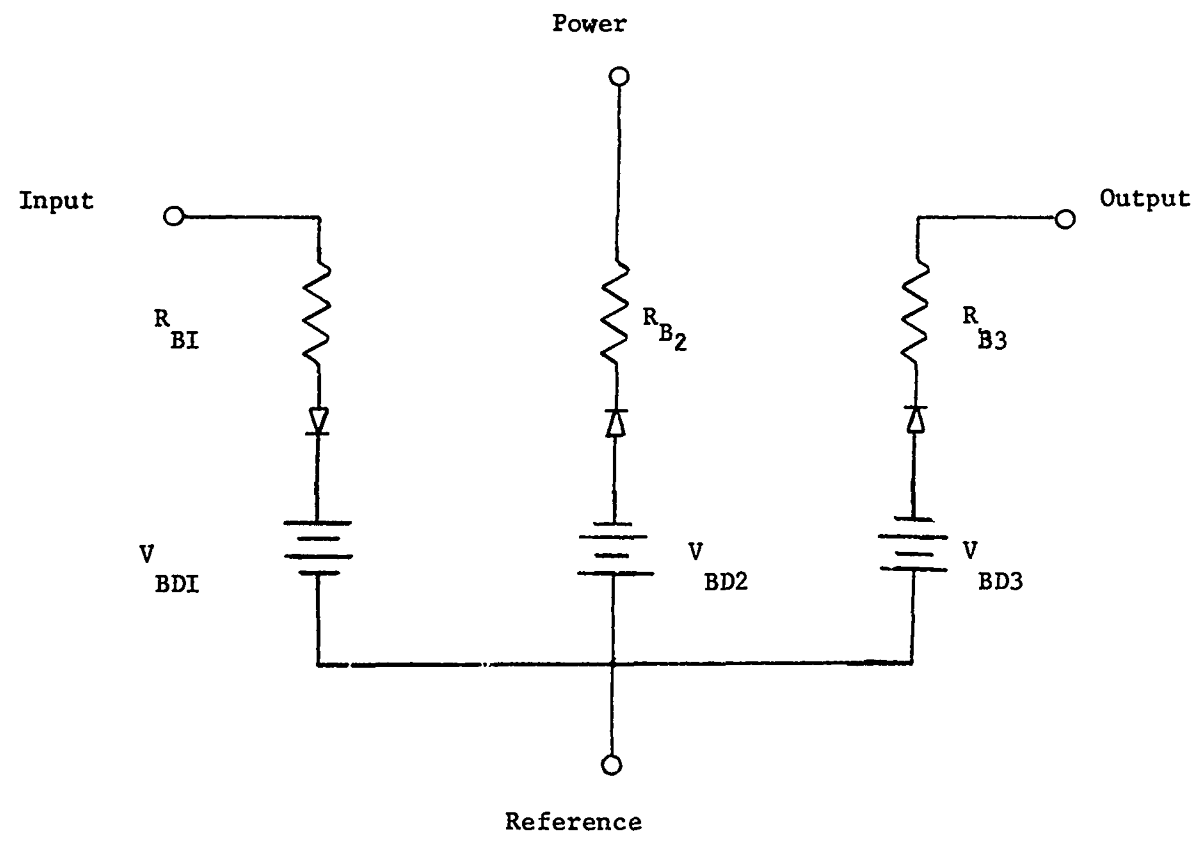


Figure 4. Equivalent Circuit Model of Jenkins & Durgin For Integrated Circuit Failure Prediction

Table 3

Range of Predicted Power Level in Watts at 1 Microsecond Pulse Width For Several Integrated Circuit Categories Using the Jenkins & Durgin Damage Model

Family	Terminal	Mean	Lower 95%	Upper 95%
TTL	Input	29	7	100
	Output	77	20	280
RTL	Input	112	25	500
	Output	66	10	400
	Power	187	50	1500
DTL	Input	41	12	120
	Output	70	20	123
	Power	112	25	500
ECL	Input	67	20	220
	Output	77	7	900
	Power	414	200	800
MOS	Input	43	5	350
	Output	116	37	380
	Power	190	70	500
LINEAR	Input	84	6	1100
	Output	267	80	800

3) DATA BASE FORMULATION AND EVALUATION

3.1) Data Base Formulation

The overall objective of this program was to develop engineering type prediction techniques in order to predict both the surge impedances and failure thresholds of small scale integrated circuits when exposed to EMP type environments. In order to achieve this objective, an extensive amount of test data was obtained from a literature search of numerous DOD and NASA agencies and contractors. This data was stored in a computer data bank for the subsequent model development.

Since it was required to develop a prediction technique for the pulse or surge impedance, the data base was required to be defined down to the level of at least the average pulse voltage and average pulse current associated with each experimental data point, rather than down to just a pulse power-time definition. In many cases, this format was not readily available. As such, more experimental data points were available for the development of a power damage model than were available for a pulse impedance model or a current damage model. Obtaining data down to the pulse voltage and pulse current level was also desirous for other important reasons. For example, a damage current representation provided a direct insight into the predominant damage model exhibited by a particular class of devices. Here, by examining the time dependence of damage current, the prevalent failure mode for instance, bulk (I^2R) type heating or direct junction (VI) type heating can be ascertained. Similarly, voltage dependent failures could also be ascertained. By properly recognizing and segregating these various damage mechanisms, a more accurate and flexible prediction tool can be developed.

Ideally, it would have been preferable to acquire all data down to the level of obtaining the oscilloscope traces associated with the respective voltage and current pulses. This, admittedly, would be impractical and cost ineffective in many cases. However, the experience in this program and with other similar activities with literature search obtained data has revealed instances when experimenters incorrectly considered lead inductance response in defining pulse power levels in devices. These instances were uncovered in those cases where oscilloscope trace data were also made available and such comparisons could easily be made. As such, it is conceivable that some situations may be encountered where the impact of incorrect data is worse than no data at all and the statistics associated with any model developed could be adversely affected. Whenever the raw data which was obtained exhibited characteristics such as excessive noise (or ringing), voltage and or current traces partially off scale, or too faint traces, the data were

eliminated rather than jeopardizing the modeling effort because of the inclusion of bad data. In order to maintain consistancy throughout the data base, the failure time was always taken to be the pulse width rather than the experimenters subjectively determined failure time.

In addition to the electrical pulse response data on a particular device, it was also necessary to obtain the electrical parameters and the construction type for every device in the data bank. The resulting electrical parameter and electrical pulse data that were included in the data bank were the following:

Device Type
Device Family Type (i.e., DTL,RTL,etc.)
Functional Classification (i.e. NAND Gate,etc.)
Manufacturer (per Data Book Code)
Isolation Technique (junction or dielectric)
Resistor Type (thin film or diffused)
Pin Pair Pulsed and Polarity
Pulse Width
An indication of damage or no damage
Average Power
Voltage min, max, and average (during the pulse)
Current min, max, and average (during the pulse)
Impedance min, max, and average
Breakdown Voltage (VBD)
Bulk Impedance (Vavg-VBD)/Iavg
Thermal Resistances
Supply Current (typical)
Output Current (typical)
Input Current (typical)
Propagation Delay Time (Digital IC's only)
Gain Bandwidth (linear IC's only)
Slew Rate (linear only)
Power Dissipation
Source of data

The electrical parameters that were included were chosen based on their possible correlation with the device failure threshold and their availability of these parameters for the majority of the devices in the data bank. Typical data were utilized where possible rather than min/max electrical data in order to better characterize the device.

The data base (including the experimental data generated during this program) from which all of the models were developed is summarized in Tables 4 - 7. These tables show the specific device types and the number of data points as a function of pulse width for five categories of devices. The meanings of each of the headings on the tables are the following:

Device: part type

Table 4

Summary of the Data Base Points Available for Transistor-Transistor Logic Devices

DEVICE	FUNCTION	MANU	SOD	T=1ØNS			T=1ØØNS			T=1US			T=1ØUS		
				IN	OUT	VCC	IN	OUT	VCC	IN	OUT	VCC	IN	OUT	VCC
MC4Ø43	LINE-SEL.	MOT	1	Ø	Ø	Ø	4	2	Ø	4	4	Ø	8	8	Ø
74ØØDC	2IN-NAND	FSC	1	Ø	Ø	Ø	4	Ø	Ø	4	4	Ø	8	1Ø	Ø
MC74ØØL	2IN-NAND	MOT	1	Ø	Ø	Ø	4	Ø	Ø	4	2	Ø	8	1Ø	Ø
SN749Ø	DECADE-COUNT	TIX	1	Ø	Ø	Ø	4	Ø	Ø	4	4	4	8	8	6
SN74163	4-BIT-COUNTE	TIX	1	Ø	Ø	Ø	4	4	Ø	4	4	Ø	8	8	Ø
MC4ØØ6	BINARY-DECOD	MOT	1	Ø	Ø	Ø	4	4	Ø	4	4	Ø	8	8	Ø
SN74ØØ	2IN-NAND	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	4	Ø	4	8	Ø
SN74Ø2	2IN-NOR	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	4	Ø	8	8	Ø
SN7413	SCHMITT-TRIG	TIX	1	Ø	Ø	Ø	4	Ø	Ø	4	4	Ø	8	8	Ø
N74ØØF	2IN-NAND	SIG	1	Ø	Ø	Ø	4	Ø	Ø	4	6	Ø	8	8	Ø
SN74H6Ø	4IN-EXPANDER	TIX	1	Ø	Ø	Ø	4	Ø	Ø	6	Ø	Ø	14	Ø	Ø
SN74HØØ	2IN-NAND	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	4	Ø	8	8	Ø
SN74HØ5	HEX-INVERTER	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	1Ø	Ø	Ø	16	Ø	Ø
SN74LØØ	2IN-NAND	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	8	Ø	Ø
SN74L71	RS-FLIP-FLOP	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	1Ø	Ø	Ø
SN74L73	JF-FLIP-FLOP	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	6
SN74L95	4BIT-SHIFT-R	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	4	Ø	Ø
SN74SØØ	2IN-NAND	TIX	1	Ø	Ø	Ø	Ø	Ø	Ø	4	4	Ø	7	8	Ø
6Ø41	3IN-NAND	AML	2	Ø	1	Ø	Ø	2	Ø	Ø	1	Ø	Ø	Ø	Ø
SN7491AN	8BIT-SHIFT-R	TIX	8	Ø	Ø	Ø	Ø	Ø	Ø	4	4	2	Ø	Ø	Ø
SN7472N	JK-FLIP-FLOP	TIX	8	Ø	Ø	Ø	Ø	Ø	Ø	4	6	4	Ø	Ø	Ø
DRA2ØØ1	5Ø6-BIT-SHIF	TIX	4	Ø	Ø	Ø	Ø	Ø	Ø	4	4	2	Ø	Ø	Ø
SN74LØØJ	2IN-NAND	TIX	8	Ø	Ø	Ø	6	4	2	Ø	Ø	Ø	Ø	Ø	Ø
SN54Ø4	HEXINVERTER	TIX	5	2Ø	2Ø	18	2Ø	19	2Ø	2Ø	2Ø	2Ø	Ø	Ø	Ø
54LØØ	2IN-NAND	TIX	12	Ø	Ø	Ø	33	Ø	Ø	13	Ø	Ø	Ø	Ø	Ø
54L122	MULTIVIB	TIX	12	Ø	Ø	Ø	Ø	Ø	Ø	7	9	Ø	Ø	Ø	Ø
74S112	FLIP-FLOP	TIX	13	8	8	9	7	8	7	Ø	Ø	Ø	Ø	Ø	Ø
SN74SØØ	2IN-NAND	TIX	13	7	8	8	6	7	8	Ø	Ø	Ø	Ø	Ø	Ø
54LS27	3-NOR	TIX	14	Ø	Ø	Ø	8	7	Ø	7	8	Ø	Ø	Ø	Ø
54LS74	FLIP-FLOP	TIX	14	Ø	Ø	Ø	8	7	Ø	7	8	Ø	Ø	Ø	Ø
74LSØØ	2IN-NAND	TIX	13	8	6	7	15	14	6	15	16	8	Ø	Ø	Ø
74LS112	FLIP-FLOP	TIX	13	1Ø	7	8	8	8	7	8	7	8	Ø	Ø	Ø
74L122	MULTIVIB	TIX	13	7	8	4	Ø	5	7	Ø	Ø	Ø	Ø	Ø	Ø
SN74LØØ	2IN-NAND	TIX	13	4	6	3	Ø	3	4	Ø	Ø	Ø	Ø	Ø	Ø
SN74LØ4	HEX-INV	TIX	14	4	4	4	7	7	Ø	8	6	Ø	Ø	Ø	Ø

Table 5

Summary of the Data Base Points Available for Linear Devices

DEVICE	FUNCTION	MANU	SOD	T=1ØNS IN	T=1ØNS OUT	T=1ØNS VCC	T=1ØØNS IN	T=1ØØNS OUT	T=1ØØNS VCC	T=1US IN	T=1US OUT	T=1US VCC	T=1ØUS IN	T=1ØUS OUT	T=1ØUS VCC
LM1Ø5	REGULATOR	NSC	1	Ø	Ø	Ø	Ø	4	Ø	Ø	4	Ø	Ø	8	Ø
7Ø9HC	OP-AMP	FSC	1	Ø	Ø	Ø	4	Ø	Ø	4	2	Ø	8	8	7
UA715	OP-AMP	FSC	1	Ø	Ø	Ø	4	4	Ø	4	4	Ø	8	8	Ø
UA74Ø	OP-AMP	FSC	1	Ø	Ø	Ø	4	Ø	Ø	4	4	Ø	8	8	Ø
UA776	OP-AMP	FSC	1	Ø	Ø	Ø	Ø	4	Ø	4	4	Ø	6	8	Ø
MC153ØG	OP-AMP	MOT	1	Ø	Ø	Ø	2	Ø	2	4	Ø	4	8	8	6
LM1Ø31.8	IC-ZENER	NSC	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	12	Ø	Ø	8
LM111H	COMPARATOR	NSC	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1Ø	Ø	Ø	1Ø
LM111H	COMPARATOR	NSC	1	Ø	Ø	Ø	4	Ø	Ø	3	4	4	2	4	8
LM3Ø2	V.FOLLOWER	NSC	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	6	6	Ø
UA741	OP-AMP	FSC	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
UA747	OP-AMP	FSC	1	Ø	Ø	Ø	Ø	Ø	Ø	2Ø	Ø	Ø	12	8	Ø
N571ØT	COMPARATOR	SIC	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	4	Ø
SN751Ø7	LINE-REC.	TIX	1	Ø	Ø	Ø	4	Ø	Ø	6	Ø	Ø	8	Ø	Ø
UA7Ø9	OP-AMP	FSC	6	Ø	Ø	Ø	4	Ø	Ø	4	Ø	Ø	4	Ø	Ø
MC153ØG	OP-AMP	MOT	3	Ø	Ø	Ø	1	1	Ø	1	1	2	1	1	1
7Ø9R	OP-AMP	RAD	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
SN727Ø9	OP-AMP	TIX	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
1752	OP-AMP	BUB	6	Ø	Ø	Ø	Ø	Ø	Ø	2	Ø	Ø	Ø	Ø	Ø
RA239	OP-AMP	RAD	7	Ø	Ø	Ø	2	2	2	Ø	Ø	Ø	Ø	Ø	Ø
LM3Ø1A	OP-AMP	RSC	13	5	8	8	Ø	Ø	Ø	7	3	7	Ø	Ø	Ø
LM3Ø8	OP-AMP	RSC	13	7	8	7	Ø	Ø	Ø	8	6	7	Ø	Ø	Ø
LM311	COMPARATOR	RSC	13	3	3	4	1Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
LM339	COMPARATOR	RSC	13	8	8	4	7	8	7	Ø	Ø	Ø	Ø	Ø	Ø

Table 6

Summary of the Data Base oints Available for Diode-Transistor Logic Devices

DEVICE	FUNCTION	MANU	SOD	T=1ØNS			T=1ØØNS			T=1US			T=1ØUS		
				IN	OUT	VCC	IN	OUT	VCC	IN	OUT	VCC	IN	OUT	VCC
93ØHC	4IN-NAND	FSC	1	Ø	Ø	Ø	4	4	4	4	4	6	8	1Ø	8
93ØRC	4IN-NAND	RSC	1	Ø	Ø	Ø	3	4	4	7	6	4	6	1Ø	8
932HC	2IN-NAND-BUF	FSC	1	Ø	Ø	Ø	4	4	4	7	6	4	6	8	8
933HC	HEX-INVERTER	FSC	1	Ø	Ø	Ø	4	2	Ø	4	4	Ø	8	7	Ø
DM933	HEX-INVERTER	NSC	1	Ø	Ø	Ø	4	4	Ø	4	4	Ø	5	7	Ø
944HC	2IN-NAND-BUF	FSC	1	Ø	Ø	Ø	4	Ø	4	4	8	4	8	8	8
DM944	2IN-NAND-BUF	NSC	1	Ø	Ø	Ø	4	2	Ø	4	4	2	8	8	8
945HC	RS-FLIP-FLOP	FSC	1	Ø	Ø	Ø	4	4	2	4	4	8	8	8	8
DM945	RS-FLIP-FLOP	NSC	1	Ø	Ø	Ø	4	2	4	2	4	6	1Ø	1Ø	8
946HC	2IN-NAND	FSC	1	Ø	Ø	Ø	4	Ø	4	4	4	4	8	6	8
DM946	2IN-NAND	NSC	1	Ø	Ø	Ø	4	4	4	8	4	4	8	8	4
DM948	RS-FLIP-FLOP	NSC	1	Ø	Ø	Ø	4	4	4	8	4	4	8	8	8
MC1488	LINE-DRIVER	MOT	1	Ø	Ø	Ø	4	8	Ø	4	8	Ø	8	8	Ø
MC1489	QUAD-LINE-RE	MOT	1	Ø	Ø	Ø	8	4	Ø	8	4	Ø	14	8	Ø
SE156	2-4IN-LINE-D	SIC	1	Ø	Ø	Ø	Ø	Ø	Ø	4	Ø	Ø	4	Ø	Ø
SE18ØJ	4-2IN-NAND	SIC	1	Ø	Ø	Ø	2	Ø	Ø	4	Ø	Ø	13	Ø	Ø
MC93Ø	NAND	MOT	11	Ø	Ø	Ø	15	Ø	Ø	11	Ø	Ø	27	Ø	Ø
RD21Ø	EXPANDER	RAD	11	Ø	Ø	Ø	4	Ø	Ø	9	Ø	Ø	14	Ø	Ø
F45Ø1	4IN-NAND	FSC	4	Ø	Ø	Ø	3	Ø	Ø	5	Ø	Ø	15	Ø	Ø
RD22Ø	HEXINVERTER	RAD	7	Ø	Ø	Ø	19	28	4	Ø	Ø	Ø	Ø	Ø	Ø
RD211	EXPANDER	RAD	7	Ø	Ø	Ø	18	Ø	Ø	3Ø	Ø	Ø	Ø	Ø	Ø
RD211B	EXPANDER	RAD	7	Ø	Ø	Ø	63	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
RD221	BINARY	RAD	7	Ø	Ø	Ø	Ø	25	6	Ø	Ø	Ø	Ø	Ø	Ø
F993Ø	5IN-EXTENDER	FSC	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
TI946	2IN-NAND	TIX	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
SE8481	2IN-NAND	SIC	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
SG14Ø	SYL	DTL	3	Ø	Ø	Ø	1	1	1	1	1	1	1	1	1
RD21Ø	EXPANDER	RAD	11	Ø	Ø	Ø	4	Ø	Ø	9	Ø	Ø	14	Ø	Ø

Table 7

Summary of the Data Base Points Available For Resistor-Transistor Logic and Emitter Coupled Devices

DEVICE	FUNCTION	MANU	SOD	T=10NS IN	T=10NS OUT	T=10NS VCC	T=100NS IN	T=100NS OUT	T=100NS VCC	T=1US IN	T=1US OUT	T=1US VCC	T=10US IN	T=10US OUT	T=10US VCC
908HC	ADDER	FSC	1	0	0	0	4	4	4	8	4	4	4	8	8
909HC	BUFFER	FSC	1	0	0	0	4	4	4	8	4	8	8	8	8
910HC	NOR-GATE	FSC	1	0	0	0	2	4	8	4	4	8	12	8	8
911HC	DUAL-GATE	FSC	1	0	0	0	4	6	4	6	4	4	10	8	8
912HC	HALF-ADDER	FSC	1	0	0	0	6	2	4	6	6	6	10	8	10

ECL DEVICES

DEVICE	FUNCTION	MANU	SOD	T=10NS IN	T=10NS OUT	T=10NS VCC	T=100NS IN	T=100NS OUT	T=100NS VCC	T=1US IN	T=1US OUT	T=1US VCC	T=10US IN	T=10US OUT	T=10US VCC
MC308G	JKFLIPFLOP	MOT	1	0	0	0	0	4	0	2	4	2	8	6	10
MC317F	LOGIC-TRANS.	MOT	1	0	3	0	4	0	0	4	4	4	8	8	8
MC351G	5-IN-NOR	MOT	4	0	0	0	4	2	0	4	4	0	12	4	6
MC301G	5IN-OR-GATE	MOT	3	0	0	0	1	1	0	1	1	2	1	1	1

Device:	Part type
Function:	functional description
Manu:	manufacturer
SOD	source of data, code shown in Table
T	pulse width T = 100 ns is equivalent to 30 ns $< t <$ 300 ns
IN	input terminal
OUT	output terminal
VCC	power supply terminal

A list of the Sources of Data is given in Table 8. The data base that was assembled is identified in terms of the average power, current, voltage and impedance and are given in Appendix A. The new experimental data generated during thare program is given in the same detail in Appendix B.

3.2) DATA BASE EVALUATION

The data base was examined in order to determine if there were sufficient data for the various electrical parameters to adequately assess the relationship between the power to failure and any specific electrical parameter. Histograms were utilized in order to assess the data. Ideally, the data should be uniformly distributed on a log-normal basis. The acceptable and unacceptable electrical parameters based on the criteria of at least a factor of two in data spread with reasonable uniformity are shown on Table 9. The results shown in the table were applicable for all three terminals, (input, output, and power supply) of the devices in that category.

For another important parameter, VB, the breakdown voltage, the data spread was quite dependent on the device terminal. Since the parameter was not available on specification sheets and must be measured, insufficient data were readily available. All of the data for this parameter were either generated on this program or came from reference 1. There was sufficient data spread in this parameter for the following categories:

RTL	output
DTL	output,power supply
TTL	input,output
Linear	input,output,power supply

The results of the electrical parameter regression analyses are given in Section IV.

3.3) ERROR SOURCES IN THE DATA

The pulse power damage data that presently esist have usually been generated by step stressing the device under test using single shot, unipolarity square wave pulses of increasing power level and fixed time duration until device damage occurred. The power level step was generally set up

Table 8

Sources of Experimental Data

1.) Integrated Circuit EMP Data Summary Boeing/BDM
D224-13044-1 BDM/A - 112-74-TR Sept 74

2.) Pulsed-Power Burnout of Integrated Circuits
R.H. Vandre Aerospace Corporation Aug. 1972 AD-752540

3.) Pulse Power Testing of Microcircuits, Jack Smith
RADC-TR-71-59, Rome Air Development Center, Oct. 1971

4.) LSI Vulnerability Study Raymond, et al
(Northrup) Research & Technology Center,
DNA 2865F Oct. 1972

5.) Theoretical and Experimental Studies of Semicondutor Device
Degradation Due to High Power Electrical Transients, Tasca,
Peden, Andrews, Dec. 1973
GE Rpt No. 73SD4289

6.) Lance Data Report Supplied to GE-SS) under contract #
DAAG 39-74-C-0090

7.) Minuteman III RE-Entry Systems Alecs-G Program Piece Parts Support Test
Final Report. Dante Tasca January 1970 GE. DOC NO. 70SD401

8.) IC Damage Data from H. Domingus of Clarkson College of Technology

9.) Integrated Circuit Model Development for EMP
C. Kleiner et al Autonetics Report X74-745/501 July 1974

10.) Advanced Electro-Optical System Hardening: Phase 1 - EMP/IEMP
Susceptibility of HOST Sensor Electronic Components, W. Vault,
L. Harper HDL-TR-1722 DEC. 1975

11.) Electro-Thermal Overstress Failure in Microelectronics,
H. Domingos

12.) IC Damage Data from W. Vault of HDL

13.) IC Damage Data from present contract

14.) IC Damage Data from GE DSCS III Project

Table 9. Evaluation of Electrical Parameters Data Suitability for Regression Analysis

Category	Acceptable Parameters	Unacceptable Parameters
RTL	I_s, Tpd, Pwr, Io, Iin	θ_{JA}, θ_{JC}
DTL	I_s, Tpd, Pwr, Io, Iin	θ_{JA}, θ_{JC}
ECL	I_s, Tpd, Pwr	θ_{JA}, θ_{JC}, Iin, Io
TTL	θ_{JA}, θ_{JC}, I_s, Tpd, Pwr, Io Iin, Cap.	
Linear	θ_{JA}, θ_{JC}, I_s, GBW, Pwr, Io, Iin, Cap.*	

*Data on Cap. available only on devices tested as part of current effort.

Where:

I_s = supply current

Tpd = propagation delay time

Pwr = power dissipation

Io = output current

Iin = input current

θ_{JA} = thermal resistance junction to ambient

θ_{JC} = thermal resisiance junction to case

GBW = gain bandwidth

Cap = terminal capacitance

to be a factor of about two which was a compromise between cost and data accuracy. However, because the impedance of the device under test changed with injection level as different junctions in the IC breakdown, the resulting power step was often closer to a factor of 3.

The highest no-damage stress level and the damage level were combined in most models. This results in a quantization type of error in the measure of the failure power of approximately the square root of the power increments or about 1.4 to 1.7. Thus, the sigma of any model generated using this type of data cannot be any smaller than a factor of 1.4 to 1.7. An example of this is shown in Figure 5.

Another source of error that was quite prevalent for pulse widths of 100 nanoseconds and less was the lead inductance response of the test fixture and the device itself. For example, just a half inch of #28 wire has an inductance of about 5 nanohenries. With a pulse amplitude of 20 amps and a rise time of 2 nanoseconds, this would result in a voltage spike of 50 volts. This can lead to significant errors in the determination of both the voltage and the power of the device under test. Still another problem in the accuracte measure of the pulse voltage across a device comes about when using a relatively high impedance resistor to sample the voltage. When the input pulse power is high and the attenuation of that pulse through the attenuator is also high, then a significant amount of noise energy can be coupled from the pulser across the voltage sampling resistor. This can lead to excessive noise on the oscilloscope line and erroneous results.

For these reasons, a current failure model should be more accurate than one based on voltage or power. Indeed, the data, as shown in Section IV, bear this contention out.

The experimental results from part testing of the 74L122 on this program were unusually high when compared to the test results of other low power TTL parts. It is believed that this was caused by the circuit used to check the performance of this device. This circuit could not detect the onset of device damage and could only detect catastrophic device damage. This data was therefore not used in the modeling effort.

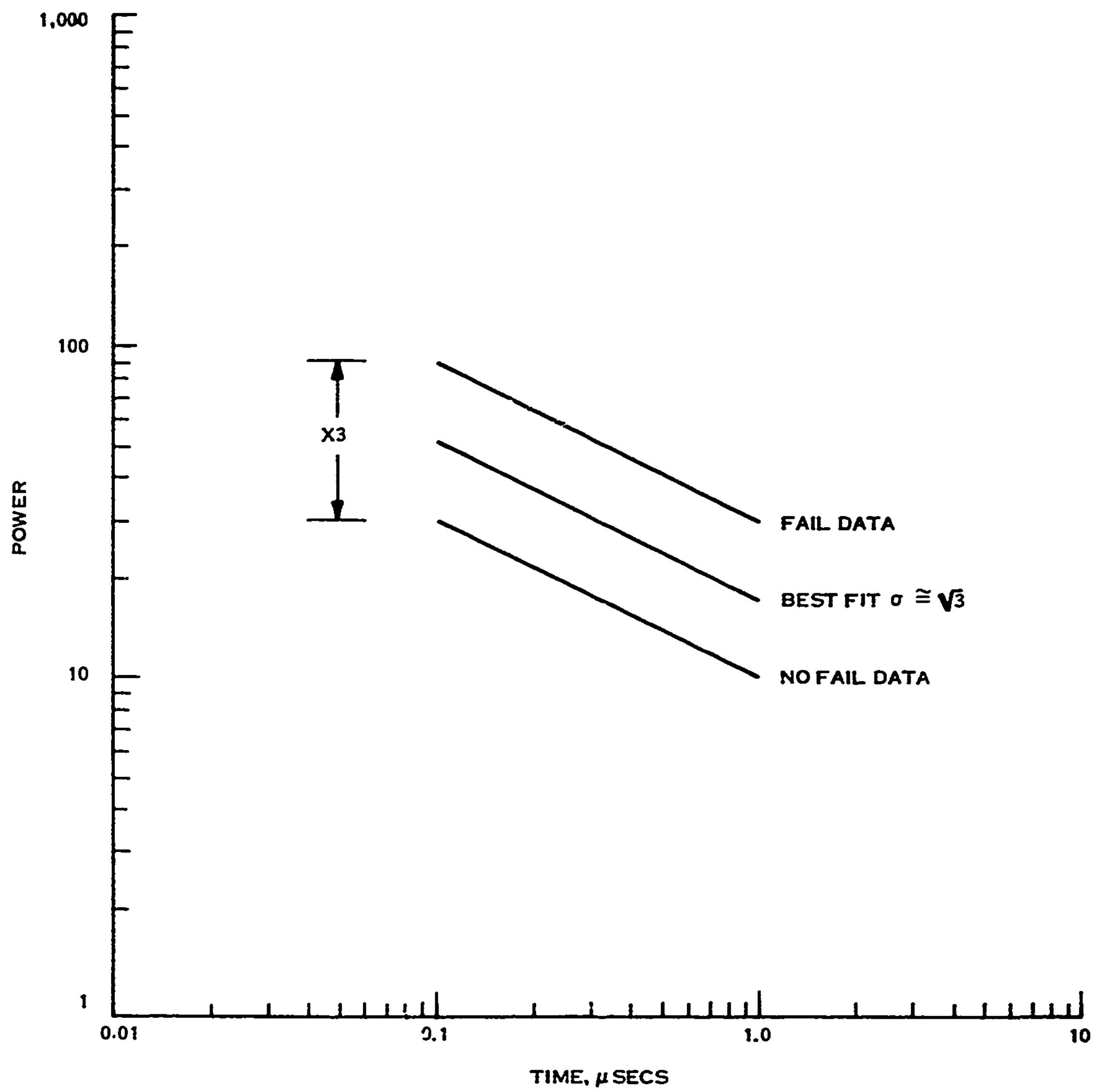


Figure 5. Example of Ideal Test Results and Resulting Quantization Type Errors

4) EXPERIMENTAL PROGRAM

4.1) GENERAL DESCRIPTION

The objective of the experimental program was to fill in the data base for those device types for which some terminal pairs were incompletely characterized, to extend the existing data base to the 10 nanosecond pulse widths and to provide sufficient data in order to establish failure models for different categories of IC's. Some of the more recent IC families (e.g. Schottky and Low Power Schottky TTL) were examined in order to determine if these device types constitute a separate category or if they were very similar to the standard TTL family of devices. Table 10 shows the pulse test matrix of devices that were chosen to be experimentally evaluated on this program. The columns on this table are:

1)	Device	part type
2)	Function	functional description of device
3)	Pulse Width	self-explanatory
4)	M&L	most and least susceptible polarity
5)	Input/Output/Power to ground)	pin-pair tested (with respect

In all cases, at least two devices were tested for each test condition of pin-pair, polarity and pulse width.

A total of 252 units were stressed to failure. All of the testing was of a step stress nature using single shot, unipolarity, square wave pulses. That is, single pulses of increasing power level and fixed time duration were consecutively applied to the selected device terminal pair until permanent damage occurred. The occurrence of damage was determined by examining the device functional operating characteristics before and after each pulse. The pulse testing was performed at fixed increasing input current increments (factor of 2) which would result in power increments of a factor of 2 for a fixed impedance.

Prior to the start of the pulse damage testing, all of the integrated circuit units were measured and characterized in the General Electric, Space Division Parts Laboratory. These measurements included the normal manufacturers specified parameters plus the pin to pin breakdown voltages and pin to ground capacitances. The breakdown voltages were measured for IN-gnd, gnd-IN, output-gnd,...etc. at 10 microamperes. This current value was chosen to be high enough to give a useful data yet low enough to preclude damaging any of the devices. Capacitance was measured with zero volts DC bias and 25 millivolts AC voltage for every device terminal with respect to ground. Capacitance was measured in this way to prevent junction turn-on.

Table 10

Pulse Test Matrix of Devices That Were Experimentally Evaluated

DEVICE	FUNCTION	PULSE WIDTH																	
		10 nsecs						100 nsecs						1 usec					
		Input		Output		Power		Input		Output		Power		Input		Output		Power	
		M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L
74S00	Quad 2 In. NAND	X	X	X	X	X	X		X	X	X	X	X						
74S112	JK Flip-Flop	X	X	X	X	X	X	X	X	X	X	X	X						
74LS00	Quad 2 In. NAND	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
74LS112	JK Flip-Flop	X	X	X	X	X	X	X	X	X	X	[illegible]	X	X	X	X	X	X	X
74L00	Quad 2 In. NAND	X		X	X	X				X		X							
74L122	Multivibrator	X		X		X				X		X	X						
74L04	Hex Inverter	X		X		X													
LM301A	OP AMP	X	X	X	X	X	X							X	X	X	X	X	X
LM308	OP AMP	X	X	X	X	X	X							X	X	X	X	X	X
LM339	Comparator	X	X	X	X	X	X	X	X	[illegible]	X	X	X						
LM311	Comparator	X		X		X													

M = Most susceptible polarity

L = Least susceptible polarity

X = Device, terminal polarity chosen for test

Upon completion of the detailed electrical parameter characterization, the devices were subjected to the pulsed environment to establish their damage threshold levels and to determine pulse impedance characteristics. As indicated previously, the occurrence of damage was determined by examining the device functional operating characteristics which were obtained prior to the initial pulse and following each subsequent pulse of energy: Typical measurements were as follows. on digital devices, input threshold voltage to turn the device on and off were measured (including on and off voltage levels), and on analog devices,gain was measured as well as input offset voltages and currents.

4.2) PULSE TEST CONFIGURATION AND INSTRUMENTATION

The pulse test experiments on the IC units were performed under ambient temperature and pressure conditions, placed in a test fixture without heatsinking, and exposed to a high energy power pulse while monitoring the current delivered to the device and the voltage developed across the device. A further requirement was that the test fixtures minimize, device lead, fixture, and stray inductances and capacitances to insure meaningful experimental data.

The pulse voltage instrumentation utilized high frequency carbon composition resistors for device voltage monitors. The voltage monitor resistance was chosen to be about 100 times greater than the maximum impedance exhibited by the device under test in order to maintain the accuracy of the current measurement as this impedance is in parallel with the device under test. Electrical connection to the device under test was made as close as physically possible to the device package and the voltage monitor ground was kept as close as physically possible to the test device ground in order to minimize any stray inductances.

The electrical specifications of the square wave high energy pulser that was utilized are as follows:

General Electric 4.5 Megawatt Square Wave Cable Pulser
- less than 1 nanosecond rise time
- 10 nanosecond to 20 microsecond pulse width
- 300 amperes into 50 ohms

To generate a square wave current required operating the square wave pulser in the constant current mode. This was accomplished by driving the integrated circuits through a 50 ohm series or shunt resistance and other suitable matching networks as shown in Figure 6. For much of the testing at 100 nanoseconds and above, the configuration used was to connect the pulser to a 2X attenuator teminated in a 50 ohm load. A current limiter resistor was then selected to set the current into the device under test (DUT). In this way the pulser sees a matched load and reflections are

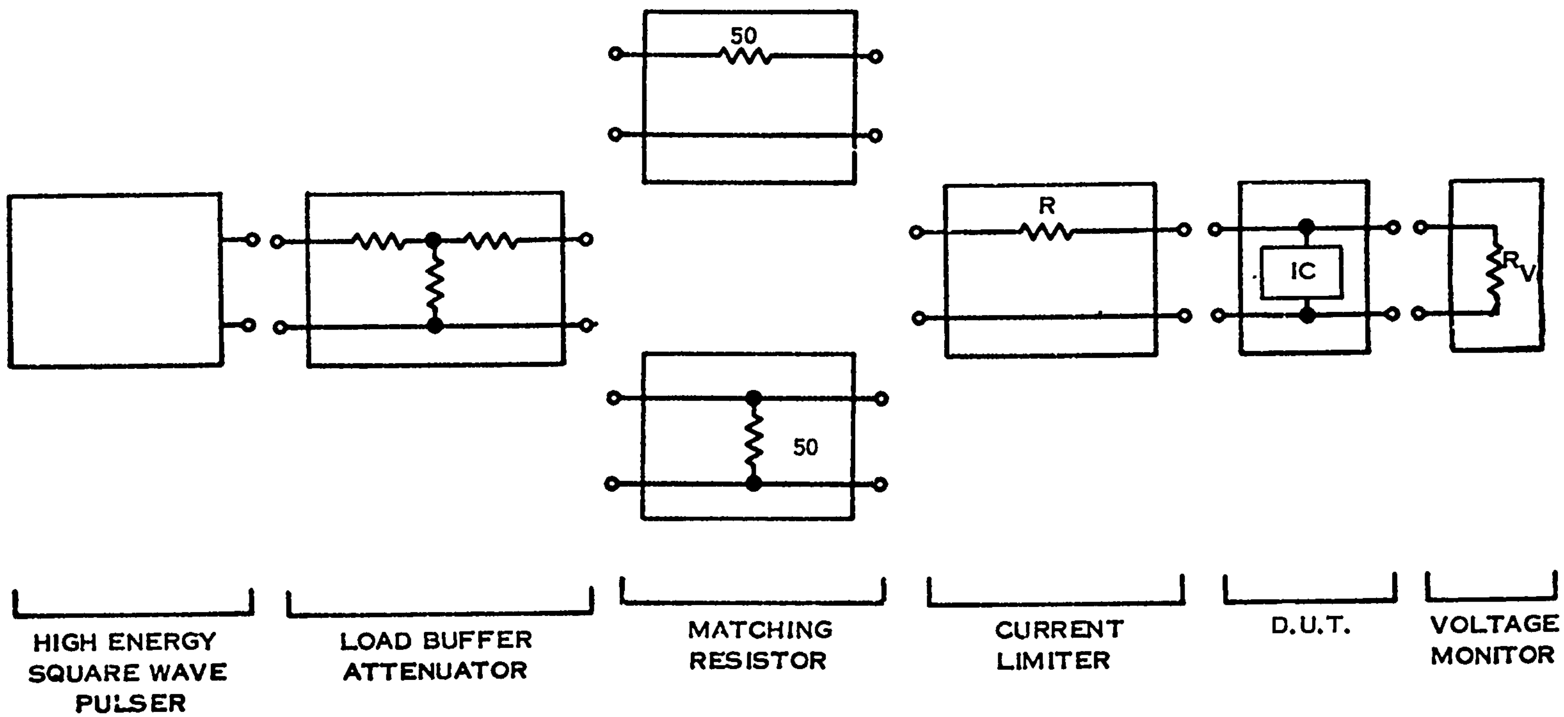


Figure 6. Square Wave Current Generator for Integrated Circuit Pulse Damage Tests

minimized. In addition, the current pulse is kept rather constant in spite of any impedance variations of the device under test, because the current limiting resistor is selected to be greater than 10 times the nominal device impedance.

4.3) DATA ACQUISITION AND REDUCTION

All pulse power data (current and voltage) were obtained using the automated computer controlled test system shown in Figure 7. This system had the capability of automatically obtaining the data-together with the proper test condition indentification and serialization- processing it, and storing it on magnetic tape for batch reduction on the H6060 computer system. The principal components of the system were as follows:

Tektronix R7912 Transient Digitizer (2)

7B50 Time Base Unit (2)
7B92 Time Base Unit (2)
7A16A Amplifier (2)
7A19 Amplifier (2)

Tektronix 632 TV Monitor

DEC PDP 11/40 Computer

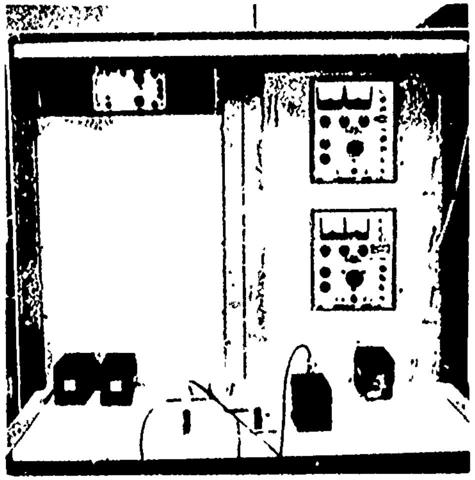
Tektronix 4010 Computer Terminal

Tektronix 4610 Hard Copy Unit

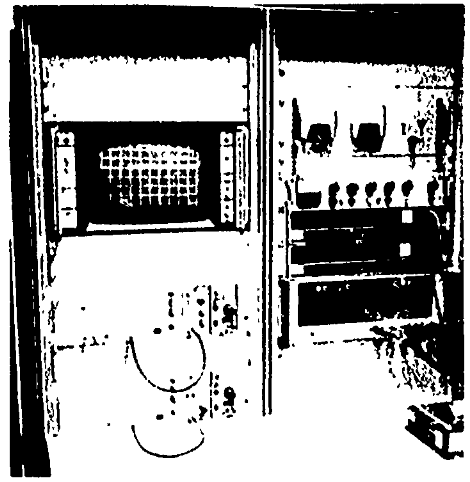
Datum 7 Track Magnetic Tape System

The pulse power data were acquired by the R7912 Digitizers, automatically processed by the PDP 11/40 Computer and stored on magnetic tape. Data identification was accomplished through the 4010 Computer Terminal.

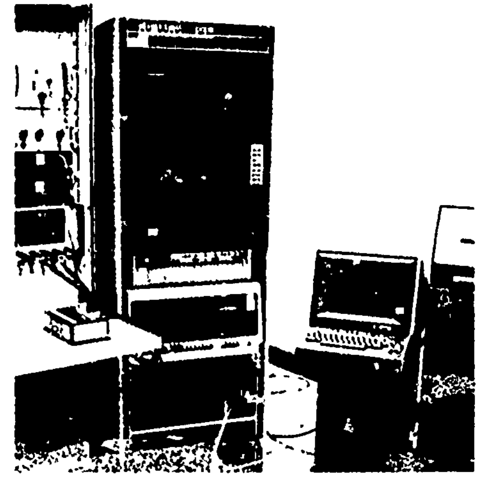
The reduced data were provided in the form of tables generated on the H6060 showing the average pulse voltage and current levels developed across the integrated circuit test unit together with the average power delivered to the test unit throughout the pulse. The reduced data were provided in the form of a computer printout defining the complete pulse power-damage history of each device tested during the program.



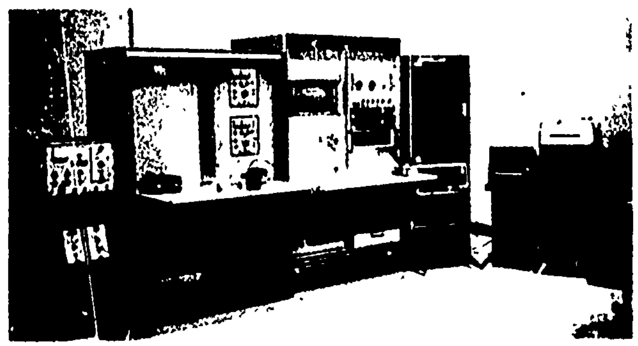
4.5 Megawatt Square Wave
Pulse Generator



Transient Digitizer
Measurement System



Computer-Magnetic Tape
Data Storage



Computer Controlled Transient Pulse Data Acquisition and Processing System

Figure 7. Data Acquisition System

5. MODELING

5.1 TECHNICAL APPROACH

The overall objective of this program was to develop engineering techniques to predict both surge impedances and failure thresholds of small-scall junction integrated circuits exposed to EMP environments. These predictive techniques provide a supplement to and improve upon the damage modeling techniques presently contained in the DNA EMP Handbook, Report No. DNA 2114H. The present handbook models do not provide any quantitative methods for evaluating device surge impedance nor does it provide the statistical information necessary for implementing high confidence hardening of electronic systems.

The approach taken in this program was as follows: (1) existing pulse damage data integrated circuits were obtained from a literature search of government agencies and their contractors; (2) the various published device specifications and construction type for each unique device identification number/manufacturer combination in the data base were obtained; (3) the published specification parameters which were common to all device types within certain functional classifications were identified; (4) multiple regression analyses of the pulse damage data versus the common specification parameters within each functional classification were performed; and, (5) the device parameters which correlated best to the experimental surge impedance and failure level values together with the prediction errors associated with each empirical model were identified.

The first three tasks required gathering all available pulse test data for integrated circuits and their associated electrical parameters. This large data base which was stored in a computer bank for subsequent analysis included the following:

- Device type
- Device family type (ie.,DTL,RTL etc.)
- Functional classification (ie.,NAND GATE,OP-AMP etc.)
- Manufacturer (per Data Book code)
- Isolation technique
- Resistor type (thin film or diffused)
- Pin pair pulsed and polarity
- Pulse width
- An indication of damage or no damage
- Average power
- Voltage min,max and average (during a pulse)
- Current min,max and average (during a pulse)

Impedance min,max,and average (during a pulse)
Bulk impedance (Vavg-VB)/Iavg)
Breakdown voltage (VB)
Thermal resistances
Supply current (typical)
Output current (typical)
Input current (typical)
Propagation delay time (digital devices only)
Gain bandwidth (linear device)
Slew rate (linear devices only)
Power dissipation
Source of data

To generate the desired models it was necessary to properly categorize the available experimental data, based on the pulse power failure mechanisms and the response characteristics of integrated circuits. Semiconductor devices operating under both biased and unbiased conditions are vulnerable to permanent damage from relatively moderate levels of pulse power even at submicrosecond pulse durations. The junction damage takes the equivalent form of a low impedance shunt being placed across the device junction and is physically the manifestation of a resolidified melt at the junction. Metallization damage, on the other hand, takes the form of melting, splattering and open circuits.

The primary physical mechanisms involved in producing device damage under pulse power conditions can generally be classified as follows:

a. Junction heating
b. Bulk semiconductor heating
c. Metallization heating
d. Voltage breakdown and arc-over

In the reverse polarity of junction current conduction, high breakdown voltage junction devices generally exhibit junction heating (because of depletion region breakdown) and channel heating (because of surface breakdown) mechanisms. Low breakdown voltage junction devices, on the other hand, generally exhibit bulk heating mechanisms. In medium voltage devices a combination of junction and bulk heating is involved. In the forward polarity of junction current conduction, bulk heating is generally the significant mechanism, independent of breakdown voltage. Metallization heating is an I^2R type of mechanism while voltage breakdown and arc-over prevalent in MOS (also possibly JFET and very high voltage bipolar junctions) are voltage dependent mechanisms. Semiconductor devices which exhibit thermal damage mechanisms fail under pulse power stressing when the temperature of the junction (or metallization) reaches a certain critical value. Models could be formated based on

pulse power causing temperature rise in a semiconductor junction. In using such a model, one must know the construction details of the device, conduction mechanisms within the device, the significant heat generation and dissipation regions within the device and the required temperature rise to failure. This is further complicated by the fact that, although in forward conduction devices are fairly well-behaved, in reverse conduction there exists a large variability in junction conditions. Either depletion region or surface breakdown can occur in a device, and this is highly dependent on device construction, surface conditions and voltage level. Nonetheless, if one knew all the required parameters, then use could be made of such models. Accumulating this information, though, represents a formidable task when trying to analyze a large number of device types from various individual manufacturers. As a result, recourse is generally made to accumulate experimental data and attempt to apply the results to particular device classes or categories. The utility of such theoretical models, is that one can identify predominant failure mechanisms within a device by examining the experimental failure level versus pulse width characteristics and from a general knowledge of the device construction.

It was considered preferable to segregate all of the experimental data obtained from the literature search based upon the type of failure. The most prevalent cause of failure due to pulsed power overstress is junction shorting, however, some devices fail from metallization burnout. Unfortunately, most of the experimental data that were obtained from previous experimental work were not identified in terms of the type of failure mechanism. Consequently, this distinction could not be made in our modeling effort.

The basic approach was, therefore, to categorize the experimental data based on device family, functional classification, manufacturer and isolation technique. Categories of parts were first chosen based on the similarities in terms of electrical and construction characteristics. Models were defined for each pin pair in each of the categories. The sigmas of these models were then compared to determine if any of these categories could be combined without sacrificing accuracy. Likewise, if a category showed models with large standard deviations (poor accuracy), then additional classes within that category were investigated. These classes were generally based either on a variation of the basic family of devices (i. e. Schottky TTL devices as a subset of TTL devices) or on further functional classification (i. e. op-amps as a subset of linear devices). Models of the power and current failure threshold as a function of time for input, output, and power supply terminals with respect to ground were generated for each of these categories and classes of ICS. These models are

tabulated in tables 14, 15, 17, 19, 20 and 21 in sections 5.2.2 - 5.2.6, along with the number of data points, the number of part types and the sigma of the model. In addition, the relationship between the power failure thresholds and the electrical parameters of the devices within each category was also examined.

In order to relate the failure threshold of a device to its electrical parameters, the following data were assembled:

Breakdown voltage (generally at 1-10 microamperes)
Thermal resistances
Supply current (·pical)
Output current (typical)
Input current (typical)
Propagation Delay Time (digital devices only)
Gain bandwidth (linear devices only)
Slew rate (linear devices only)
Power dissipation (typical)

A correlation analysis was performed for the power to fail for the input, output, and power supply terminals versus the noted electrical parameters of the devices for each significant category of ICS. For the electrical parameters that exhibited significant correlation with the power to failure, a regression analysis was performed. The effect on the sigma of the resulting model as compared to the nominal model without the electrical parameter was then utilized as the basis for deciding if the electrical parameter was a significant predictor of electrical pulse power failure threshold. In generating this nominal model it was necessary to make the number of data points equal in order to make a valid comparison. Since electrical parameter data for some part types were unavailable, this necessitated eliminating these part types when generating the nominal model for this comparison. This nominal model is, of course, not necessarily the same as the overall model for the category terminal. The criteria to discriminate between a significant and an insignificant electrical parameter model was that the model sigma should be reduced by ten percent over the nominal model in order to be considered significant.

The mathematical form of the models that were generated is expressed by:

$$P = At^{-B}$$

where P = power in watts
t = pulse width in seconds
A & B = experimentally derived constants

This formulation was chosen for both theoretical and

empirical reasons. The theoretical justification of this formulation is found in the solution of the heat equation. This formulation has been found to be good in the past for both integrated circuits and discrete devices. In addition, the data for several categories at different pulse widths were plotted on log-normal probability graph paper. The resulting plots were very close to a straight line on this type of graph paper, which indicates that the data is indeed log-normally distributed.

Previous impedance models (reference 5) were based on terms analagous to the bulk resistance, RB, and breakdown voltage VB, associated with integrated circuits in a particular category. The breakdown voltage was based on an average of measurements on the devices of the category of concern and the impedance was calculated as follows.

$$RB = (Vavg - VB)/ Iavg$$

RB = bulk impedance
Vavg = average voltage
VB = breakdown voltage
Iavg = average current

Measurements of the breakdown voltage at a 1 to 10 microamperes were made on all 11 device types tested in this program. This parameter was fairly constant for each terminal of a particular device type. The breakdown voltage is the forward direction of a terminal pair was generally not the same as in the reverse direction. The averages of these measurements are shown in Table 11 for the different TTL familes of digital logic.

Table 11

Average of Measured Breakdown Voltages
of Texas Instruments TTL Logic

Family	Breakdown Voltage					
	In		Out		Vcc	
	+	-	+	-	+	-
74SXX	6.4	0.4	5.8	0.5	0.5	0.5
74LXX	8.	0.5	15.	0.4	0.7	0.7
74LS	22.5	0.4	1.1	0.5	0.7	0.5

5. C. Jenkins and D. Durgin, "EMP Susceptibility of Integrated Circuits", IEEE Trans. Nucl. Sci. NS-22 p. 2494, 1975

These measurements plus the breakdown voltage measurements obtained from reference 1 were used to calculate the bulk impedance. The results of this calculation showed that the bulk impedance was not always a constant but rather a function of current level. This was not surprising since at high injection levels the devices often breakdown which is manifested by a change from high impedance to a low impedance. Failure of the device was a function of how much energy is dissipated in the device while it is in this low impedance state. The average impedance of the device was a function of the time spent in the low impedance state which is related to the current because the current increases as the impedance decreases. Consequently, the bulk impedance of a device could be expected to be related to the average current. A model of the average impedance, which is just the average voltage divided by the average current, was also generated. Comparison of the constant or current dependent bulk impedance model to the current dependent average impedance model showed that the average impedance models were generally better (lower standard deviations) than the bulk impedance models. This result was probably caused by the measured breakdown voltage at low current levels (1-10 microamperes) not being the same as the breakdown voltage at high injection levels. Examination of the data taken on this program indicated that this was often the case. Since an IC may have several transistors across a terminal pair the breakdown voltage at low currents need not necessarily be equal to the breakdown voltages at high current levels. In addition, several of the part types tested exhibited a decreasing bulk impedance, RB, with increasing current level.

At the shorter pulse widths, 10 nanoseconds to 1 microsecond, which was the primary area of interest in this study, these two formulations are roughly equal, as the voltage across the devices near failure are much larger than the terminal breakdown voltage. At the longer pulse widths, a bulk impedance would probably have more utility than the current dependent average impedance model. Since there were much more data for the average impedance model and dince this formulation resulted in a more accurate model, it was used.

Models of the different categories were generated by fitting the data obtained from the literature search and the data obtained from present experiments to this type ($R_{avg} = V_{avg}/I_{avg}$) of equation by the use of regression analysis. The regression analysis was set up to follow the classical least squares error procedure. This method utilizes a mathematical expression for the sum of the squared deviations from a general line. This expression is then minimized with respect to the parameters of the line. The minimization is accomplished by partial differentiating the expression for the sum of the squared error (SSE) with

1. R. H. Vandre, "Pulse Power Burnout of Integrated Circuits", The Aerospace Corporation, TR-0073(3124)-1, SAMSO-TR-226, Aug. 1976

respect to the line parameters (A&B) and equating these derivatives to zero.

$$Y_i = a + bX_i$$

$$SSE = \sum_{i=1}^{n} (Y_i - a - bX_i)^2$$

$$an + b\,\Sigma X = \Sigma Y$$

$$a\,\Sigma X + b\,\Sigma X^2 = \Sigma XY$$

Since the distribution of data is log normal and also for the theoretical reasons previously given in this section, it is desired to fit the data to an equation of the form

$$Y = aX^b$$

This can be done quite simply by the following transformations.

$$\text{LOG}\,Y = \bar{a} + b\ \text{LOG}\,X$$

$$a = \text{ANTILOG}\,(\bar{a})$$

The variance will then appear as a factor in this equation. (The following material is summarized from reference 7)

Once the regression equation ($Y = aX^b$) has been formulated, the next task is to generate confidence bands about that equation. In the application of these EMP failure models it is often desired to predict the value of Y for a future value of X. That is, if an additional device were to be tested at what stress level would it fail with a given confidence. Confidence limits for a single response prediction take the following form.

$$Yo \pm t_{\alpha/2}\, S \sqrt{1 + \frac{1}{n} + \frac{(Xo - \bar{X})^2}{Sxx}}$$

where

Yo = mean estimate of Y
T = value of t distribution at confidence $100(1-\alpha)\%$
S = sample estimate of the standard deviation
n = number of data points in sample
Xo = value of X for which limits apply
$\bar{X}$ = mean of X
Sxx = $\Sigma\,(Yi - \bar{Y})^2$

7. F. Action, "Analysis of Straight-Line Data", Dover Publications, Inc., New York 1959.

These limits are valid for only one future value of X. If it is desired to predict the value of Y for two or more values of X with a confidence 100(1 − α), a simultaneous confidence interval must be generated which takes the following form.

$$Yo \pm \sqrt{(K F_{K,\, n-2})}\ S \sqrt{1+\frac{1}{n}+\frac{(X_o-\bar{X})}{Sxx}}$$

where

Yo = mean estimate of Y
K = number of predictions
F = F distribution with k,n-2 degrees of freedom
S = sample estimate of the standard deviation
n = number of data points in the sample
$\bar{X}$ = mean of X
$Sxx = \Sigma (Xi - \bar{X})^2$
$\sigma = 10^S$

These limits are obviously not continuous across the regression line and are only valid at discrete points (Xi i=1...K). In addition the limits become quite large as the number of prediction intervals increases because of the $F_{K,\, n-2}$ term.

Because of the large limits that result from this type of prediction interval, it is seldom used. A better method would be to generate a tolerance interval which yields limits for a future experiment or sample A% of the results will be within the limits with 100(1−) confidence. These are somewhat difficult to generate and beyond the scope of this program. Consequently, it was chosen to present all of the regression results with a confidence band that yields limits for one future datum.

$$Yo \pm t_{\alpha/2}\ S \sqrt{1+\frac{1}{n}+\frac{(Xo-\bar{X})^2}{Sxx}}$$

The limits are approximately the following for a large sample.

$$Y = a t^{-b}\ 10^{S^{\pm t_{\alpha/2}}}$$

These limits are drawn across the entire curve on all of the graphs presented at a 90% confidence level. If other confidence limits are desired, then it is only necessary to change the value of t in the above equation to the value associated with the desired confidence level. For a confidence level of 95% this value of t should be 1.960, while for a 99% confidence level the value should by 2.576.

5.2) MODELS FOR INTEGRATED CIRCUIT FAMILIES

5.2.1 Types of Integrated Circuits

The approach that used to categorize each integrated circuit device type in the data base in terms of its respective device technology. This categorization was based on the expectation that the physical parameters (such as junction areas, bulk resistivity, doping, etc.) are similar and hence the response of all devices from a single family to pulse power overstress should be of the same order of magnitude. The top level classification was with respect to either a "digital" or "linear". Digital circuits were further subclassified with respect to their logic family i.e. resistor-transistor logic (RTL), diode-transistor logic (DTL), transistor-transistor logic (TTL), and emitter coupled logic (ECL). TTL type logic was further sub-divided into regular, low power, high speed, Schottky and low power Schottky TTL. Linear circuits were further classified by function. Although there were many possible functional classifications of linear devices, there were only sufficient data available to establish two categories, op-amps and comparators.

Resistor-transistor logic represents one of the earliest digital logic families. The basic RTL Circuit is shown in Figure 8. This type of logic results in one of the smallest sizes (minimum silicon chip area) for standard bipolar functions. In general, the power dissipation associated with the resistive dividers has limited its application in more modern systems. Diode-transistor logic is a later logic family that uses diodes in its input, as shown in Figure 9, to improve its performance relative to RTL. A further advantage of this type of circuit is that the number of gate inputs to any one integrated circuit may be expanded arbitrarily by using externally connected diodes. This type of logic has a relatively low noise immunity because of its high output impedance. DTL may still be used because of its compatability with TTL.

Currently, the most widely used digital circuit family is transistor-transistor logic, in which a single multi-emitter transistor replaces the input diodes and series diode of DTL. The small size of the input emitters allows a high component density. In addition, the small junction areas minimize junction capacitances which result in faster logic. Variations of the basic design shown in Figure 10 result in optimization for either speed or power consumption. For instance, low power TTL has resistor values which are four times higher than the standard TTL, thus reducing power dissipation by a factor of four. The transistors are also gold doped in order to obtain higher speed. The high speed TTL (54H) design utilizes lower resistor values and an output Darlington transistor pair to increase the speed.

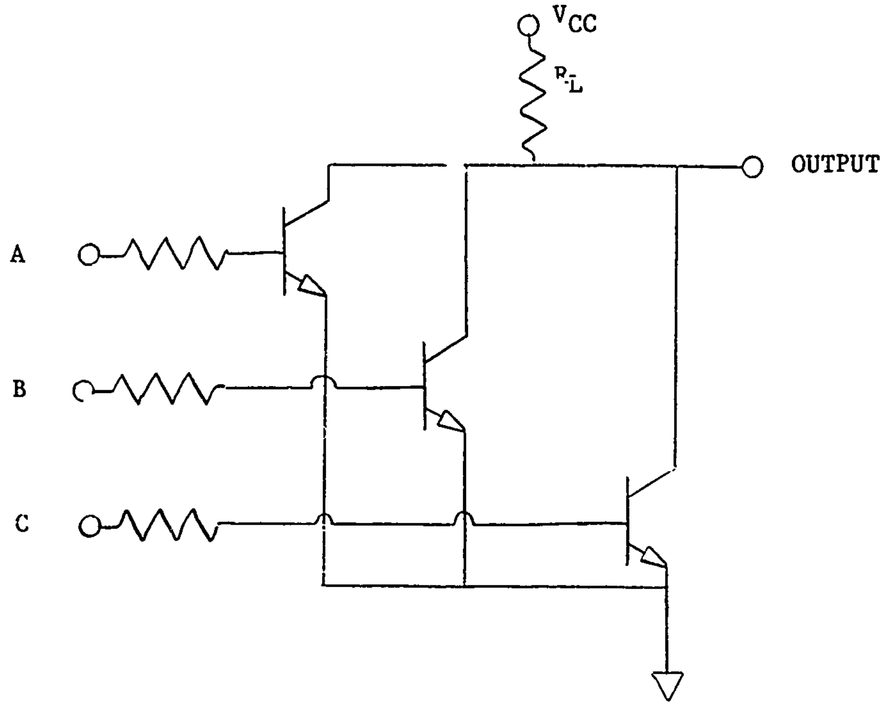


Figure 8. Basic RTL Circuit

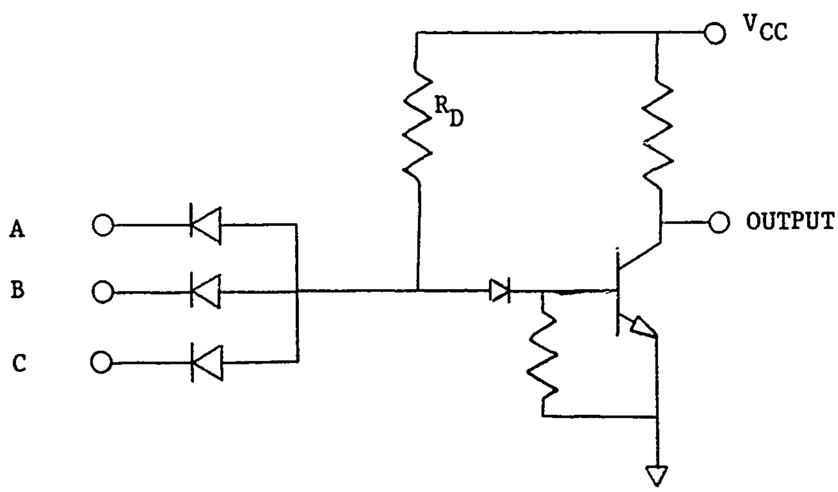
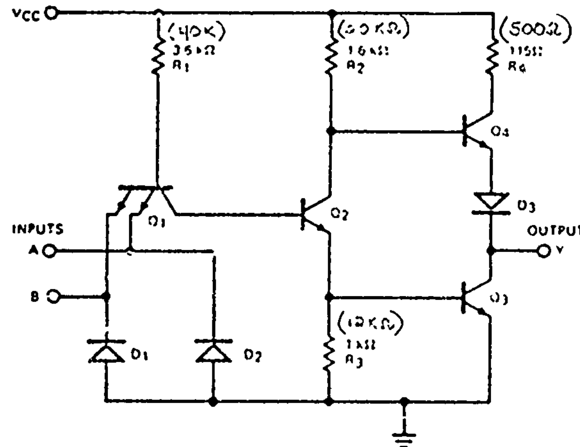
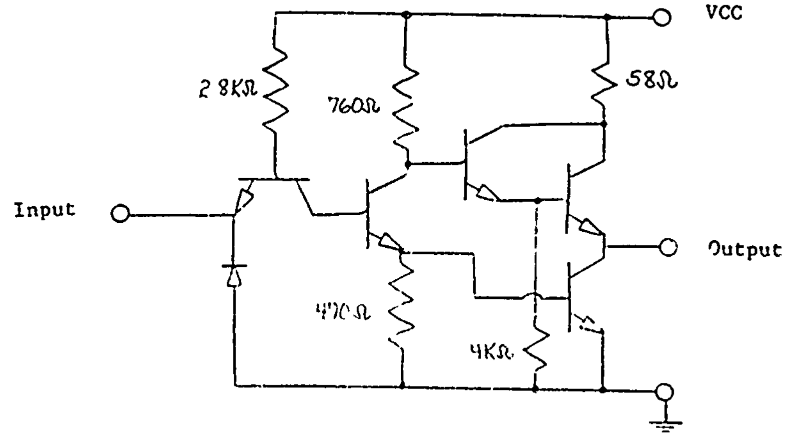


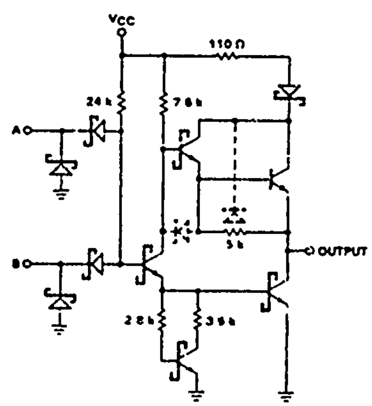
Figure 9. Basic DTL Circuit



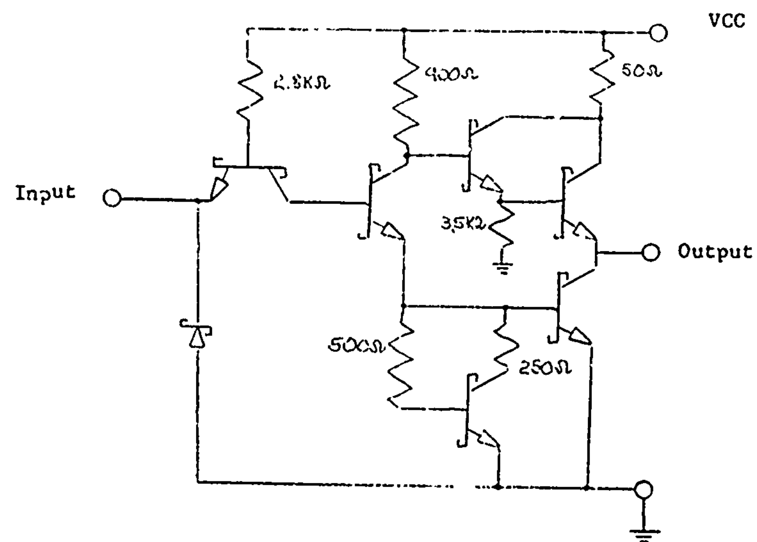
BASIC TTL GATE (LOW POWER)



BASIC HIGH SPEED TTL GATE



BASIC LOW POWER SCHOTTKY TTL GATE



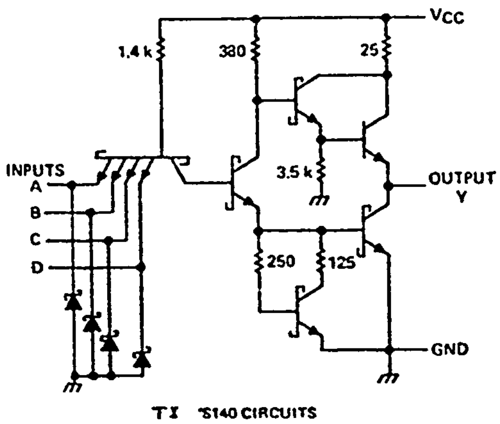
BASIC SCHOTTKY TTL GATE

Figure 10. TTL Gates

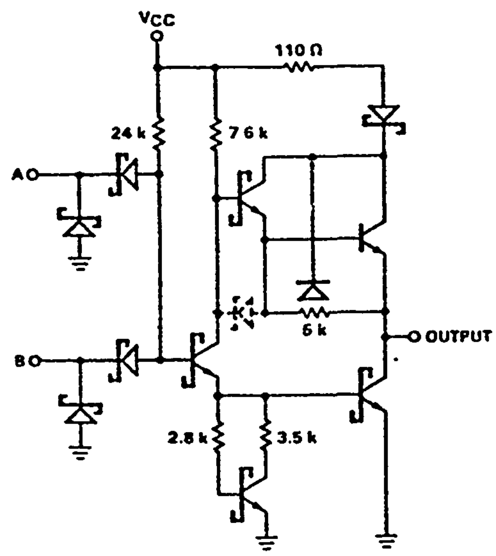
Clamping diodes have also been added on each multiple emitter input to reduce transmission line effects between device to device interconnecting lines. The resulting high speed is, however, counter balanced by higher power dissipation. The big development in TTL is the low power Schottky TTL. Although originally aimed at the military market with its low power requirements, the low power Schottky (54LS)has become the standard logic family with almost all of the new ICs being 54LS. The only other TTL family with any significant new ICs being designed is high speed Schottky (54S). This family has taken over the high speed TTL market from 54H because of its higher speed and lower power. The key to the high speed of the 54S and 54LS families is the Schottky diode. This diode is utilized in order to eliminate charge storage in the base region of the transistors without having to resort to the cumbersome gold doping used in 54L. The key features of the Schottky diode are that it does not have any minority carriers and therefore has no stored charge and the Schottky diode has a lower forward voltage than a regular silicon P-N junction. With virtually no charge stored in either the Schottky diode or the transistor, a large reduction in storage time and hence switching speed is realized. Many 54LS parts now use a Schottky diode DTL type input rather than the multi-emitter TTL transistor input. These two basic circuit designs are shown in Figure 11.

Emitter coupled logic (ECL) is a non-saturating logic which has never enjoyed the popularity of TTL. Although it is the fastest logic family presently available, its high power dissipation and unusual logic levels, which cause difficult interface problems, preclude its use as a general purpose logic family. The basic logic cell is shown in Figure 12. ECL uses a non-saturating logic structure which eliminates transistor storage time, permitting high speed operation. The fastest growing ECL family is ECL 10000 which is a slightly slower, lower power and easier to use form of ECL. Where speed is at a premium, the third generation of ECL, ECL III, which is the fastest logic, is used.

The first step in the modeling effort was to separate the electrical pulse failure threshold data into five major categories (TTL, DTL, RTL, ECL, and LINEAR). Graphs were made and a regression analysis of the failure power versus time was performed for the input, output and power terminals to ground for both the positive and negative polarities for each of these five categories. This procedure was then repeated for the failure current versus time in order to determine which type of model would yield a failure model with the tighter tolerances. Table 12 shows the one sigma limits (expressed in terms of a multiplying factor) for the regression results of both the power versus time and current versus time. Examination of this table shows that the current failure model versus time generally results in a



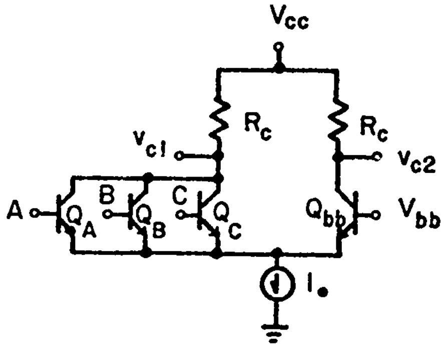
(multi-emitter input)



(diode input)

Schottky TTL Logic Gates

Figure 11. Schottky transistor-transistor logic.



basic gate

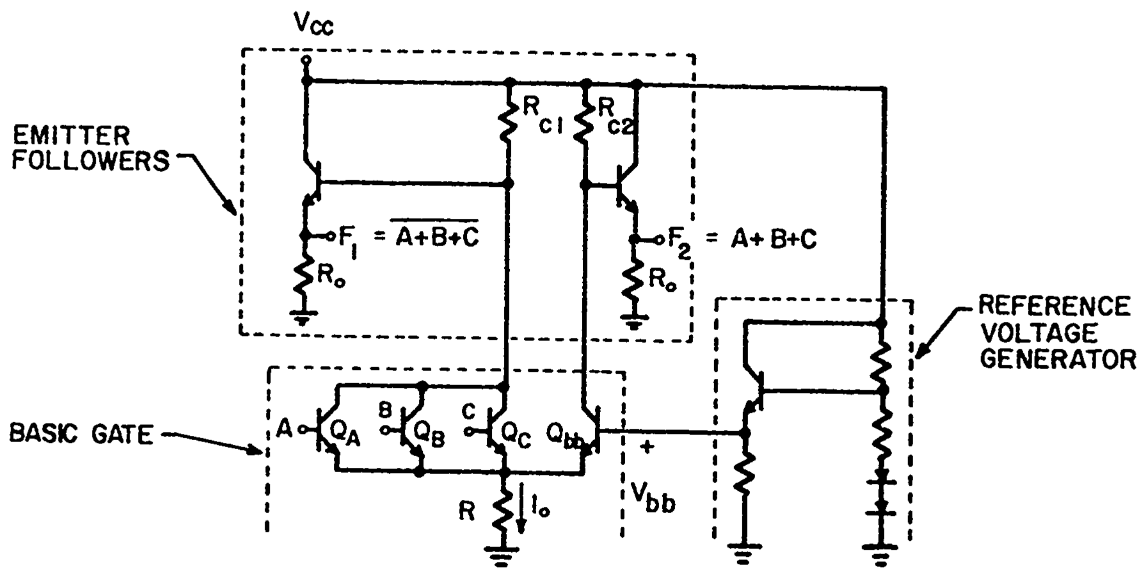


Figure 12. Emitter coupled logic

Table 12

Comparison of Sigma Values for Current and Power vs. Time Regression Results for Pin Pair Polarities Considered Separately

RTL

Terminal	SIGMA Power	SIGMA Current
In - gnd	2.15X	2.27X
gnd - In	2.08X	2.04X
out - gnd	1.62X	1.43X
gnd - out	1.42X	1.44X
pwr - gnd	1.58X	1.22X
gnd - pwr	1.51X	1.83X

DTL

Terminal	SIGMA Power	SIGMA Current
In-gnd	2.56X	1.76X
gnd - In	2.02X	1.96X
out - gnd	2.08X	1.60X
gnd - out	2.15X	1.99X
pwr - gnd	2.08X	1.66X
gnd - pwr	2.38X	1.89X

TTL

Terminal	SIGMA Power	SIGMA Current
In - gnd	2.37X	1.85X
gnd - In	2.53X	1.88X
out - gnd	2.50X	1.94X
gnd - out	2.48X	2.09X
pwr - gnd	2.53X	1.85X
gnd - pwr	3.51X	2.44X

ECL

Terminal	SIGMA Power	SIGMA Current
In - gnd	3.81X	2.34X
gnd - In	1.89X	1.51X
out - gnd	1.28X	1.33X
gnd - out	3.56X	2.11X
pwr - gnd	1.36X	1.66X
gnd - pwr	1.69X	1.39X

LINEAR

Terminal	SIGMA Power	SIGMA Current
In - gnd	4.99X	4.28X
gnd - In	4.88X	3.39X
out - gnd	2.34X	2.08X
gnd - out	3.00X	2.35X
pwr - gnd	2.39X	1.98X
gnd - pwr	4.74X	4.97X

model with tighter tolerance limits. This is to be expected since current can usually be measured more easily and accurately than voltage and hence power because of the inductance of the test fixture and other experimental considerations.

In order to determine the effect of terminal polarity on the models, this regression analysis was then repeated with both polarities of a pin pair grouped together. The one sigma limits of these regressions are shown in Table 13 for both the power and current failure models. These sigma values show that in most cases little accuracy is lost in combining the different polarity data on the same pin-pairs. The current failure model again yields tighter tolerances. The tighter tolerance limits make this modeling approach appear to be the more attractive of the two. However, in some applications of the failure models generated herein, a power failure model may be preferable to a current failure. For this reason, both types of models were generated for each category.

Two types of surge impedance models were generated for every category. The first model generated was for the bulk impedance. The bulk impedance was defined as follows:

$$RB = (Vavg-VB)/Iavg$$

where

RB = bulk impedance
Vavg = average voltage during the pulse
VB = breakdown voltage
Iavg = average current during the pulse

The other impedance model that was generated was for the average impedance (Ravg).

$$Ravg = Vavg/Iavg$$

The model that is presented for the various categories of device is the model with the lower standard deviation. In general this was the average impedance model.

The data were broken down into the five basic categories, RTL, DTL, TTL, ECL, and LINEAR. Each of these categories was investigated and subdivided until satisfactory models were obtained. For each of the categories, where data were available, the effects of manufacturer and construction were investigated. The construction investigation concerned both the isolation technique, junction or dielectric, and the resistance type, i.e. diffused or thin film. Unfortunately, the only category where sufficient data for devices of different construction types exist is the DTL category. Also investigated for all applicable categories was the dependence of the failure characteristics versus the devices

Table 13

Comparison of Sigma Values for Current

and Pcwer vs. Time Regression Results

for Pin Pairs, Both Polarities Grouped Together

RTL

Terminal	SIGMA Power	SIGMA Current
In	2.2X	2.2X
Out	1.6X	1.6X
Pwr	1.6X	1.6X

DTL

Terminal	SIGMA Power	SIGMA Current
In	2.5X	1.9X
Out	2.1X	1.8X
Pwr	2.4X	2.0X

TTL

Terminal	SIGMA Power	SIGMA Current
In	2.9X	2.1X
Out	2.4X	2.0X
Pwr	2.5X	2.0X

ECL

Terminal	SIGMA Power	SIGMA Current
In	3.6X	2.2X
Out	2.9X	2.0X
Pwr	1.6X	1.5X

LINEAR

Terminal	SIGMA Power	SIGMA Current
In	5.1X	3.6X
Out	2.6X	2.2X
Pwr	3.8X	3.1X

electrical parameters. The results of this modeling effort are summarized by category in the following sections. For each model, an equation of the least squares error fit to the data, the resulting standard deviation of the model, the 90% prediction limits for one future datum point, the number of part types in the data and the number of data points, are given and the experimental data were also presented in a graphical format. The format for the data points shown in the graphs is as follows.

(a) the symbol "*" corresponds to 1 data point
(b) the numbers "2" through "9" correspond to 2 through 9 data points respectively;
(c) the letters "A" through "Z" correspond to 10 through 35 data points respectively;
(d) the symbol "$" corresponds to greater than 35 data points.

All model units are either power in watts, current in amperes, impedance in ohms or time in seconds. A part type was considered to be each unique part identifier and manufacturer. In addition if the same part type was tested by two different experimenters then this was considered to be two different part types. The reason for this is that the results from two experimenters are often quite different. This was also done in order to account for possible variations in manufacturing processes, device design and fabrication unknowingly encountered by various experimenters whose evaluations were performed at different time periods.

5.2.2) RESISTOR-TRANSISTOR LOGIC MODELS

All of the experimental data for this category of devices come from one source (source 1of Table 8). This data consisted of five RTL devices, all manufactured by Fairchild Semiconductor (FSC). These devices were all manufactured using an epitaxial process with diffused resistors. Since there was no manufacturing or construction differences in this data category, no assessment of their effects could be made. Table 14 tabulates all of the significant models that were developed for this category while Figures 13-17 display some of these models in a graphical format in order to give the reader a feel for the data.

The input terminal's power failure threshold showed a correlation to both the propagation delay time (in seconds) and the typical power dissipation (in milliwatts). The inclusion of these two parameters reduced the resulting sigma of the model from 2.2X to 1.7X. This model is shown on Figure 18. The range of data for the propagation delay time is not large, 40 nanoseconds to 100 nanoseconds, while the spread of data for the typical power dissipation was 6 milliwatts to 20 milliwatts. As would be expected the devices with the higher power dissipation had the higher power failure threshold. The slower, larger propagation delay time devices also had the higher power failure thresholds. No other electrical parameter showed any strong

Table 14. Summary of RTL Models

Model	Input	σ	# Points	# Types	Output	σ	# Points	# Types	Power	σ	# Points	# Types
P_{avg}	$P = 0.09\ t^{-0.52}$	2.2X	96	5	$P = 0.07\ t^{-0.37}$	1.63X	82	5	$P = 0.25\ t^{-0.49}$	1.6X	96	5
I_{avg}	$I = 0.012\ t^{-0.35}$	2.2X	96	5	$I = 0.053\ t^{-0.27}$	1.4X	82	5	$I = 0.041\ t^{-0.31}$	1.74X	96	5
R_{avg}	$R = 79.84\ I^{-0.99}$	1.85X	96	5	$R_{avg} = 18.9\ I^{-0.7}$	1.44X	82	5	$R = 67.3\ I^{-0.866}$	1.61X	96	5
P_{avg}	$P = 2.7 \times 10^{8}\ tpd^{1.39}\ p^{0.88}\ t^{-0.45}$	1.73X	96	5								

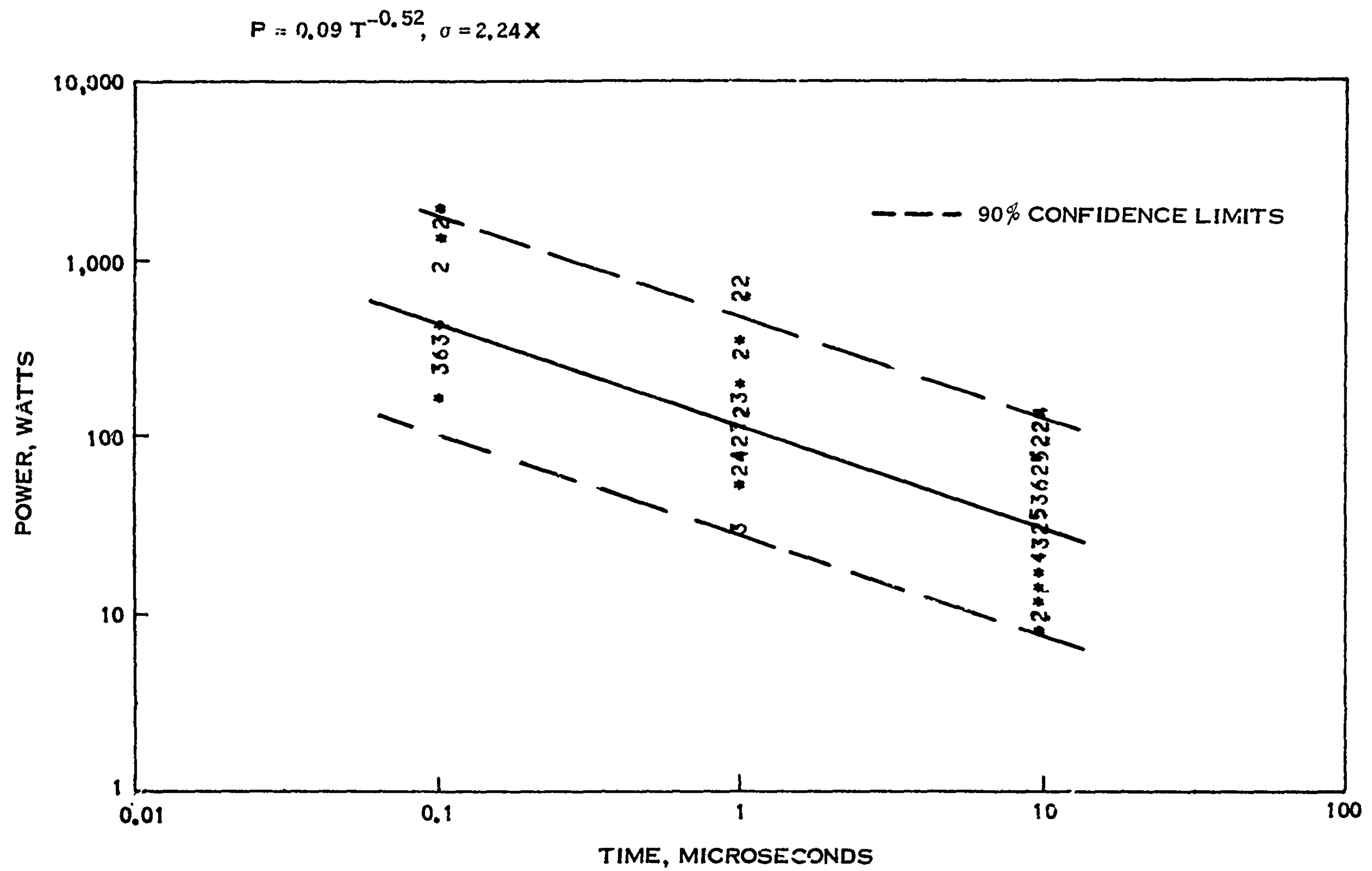


Figure 13. Input Power Failure Model for RTL Devices

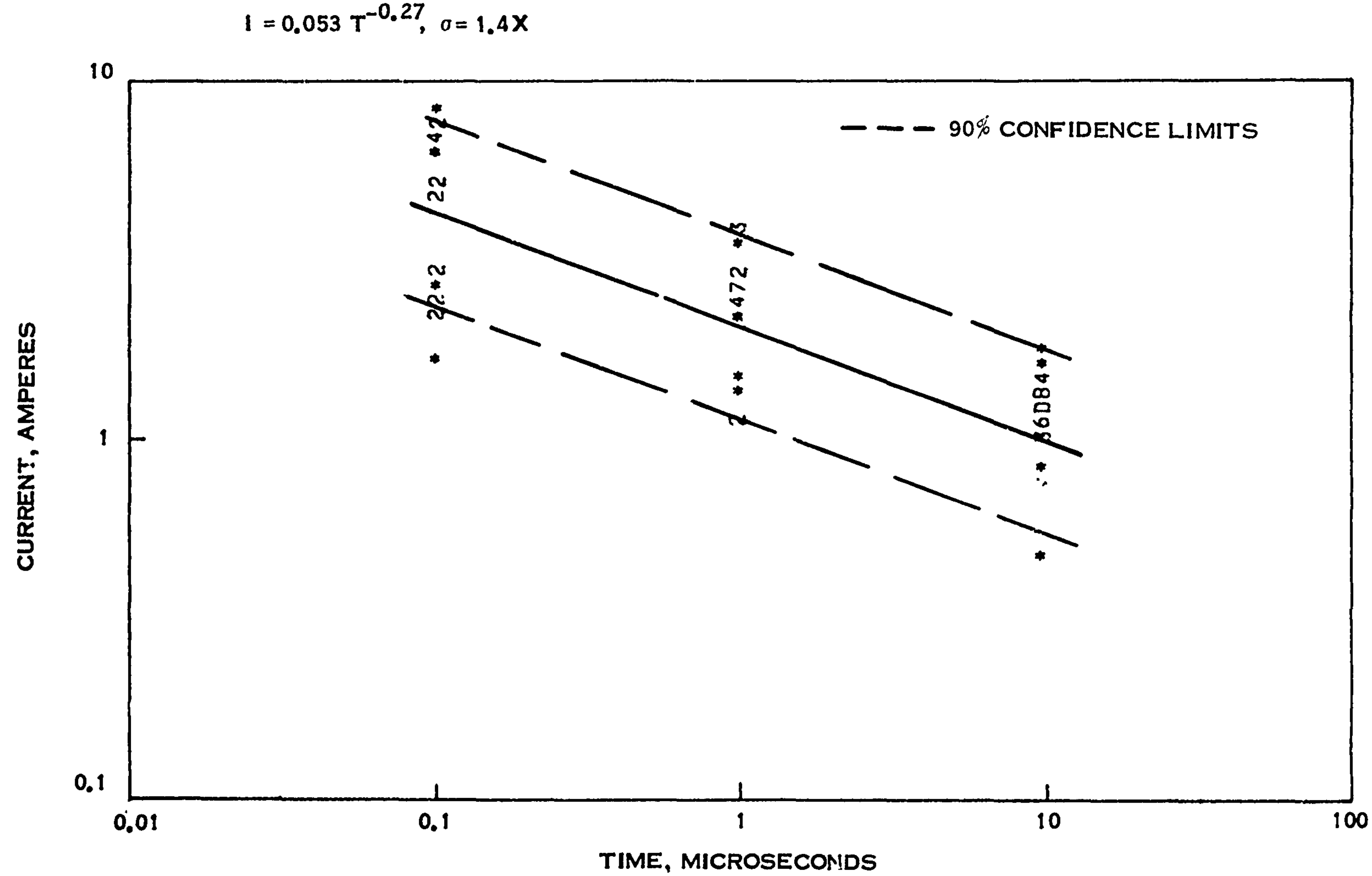


Figure 14. Output Current Failure Model for RTL Devices

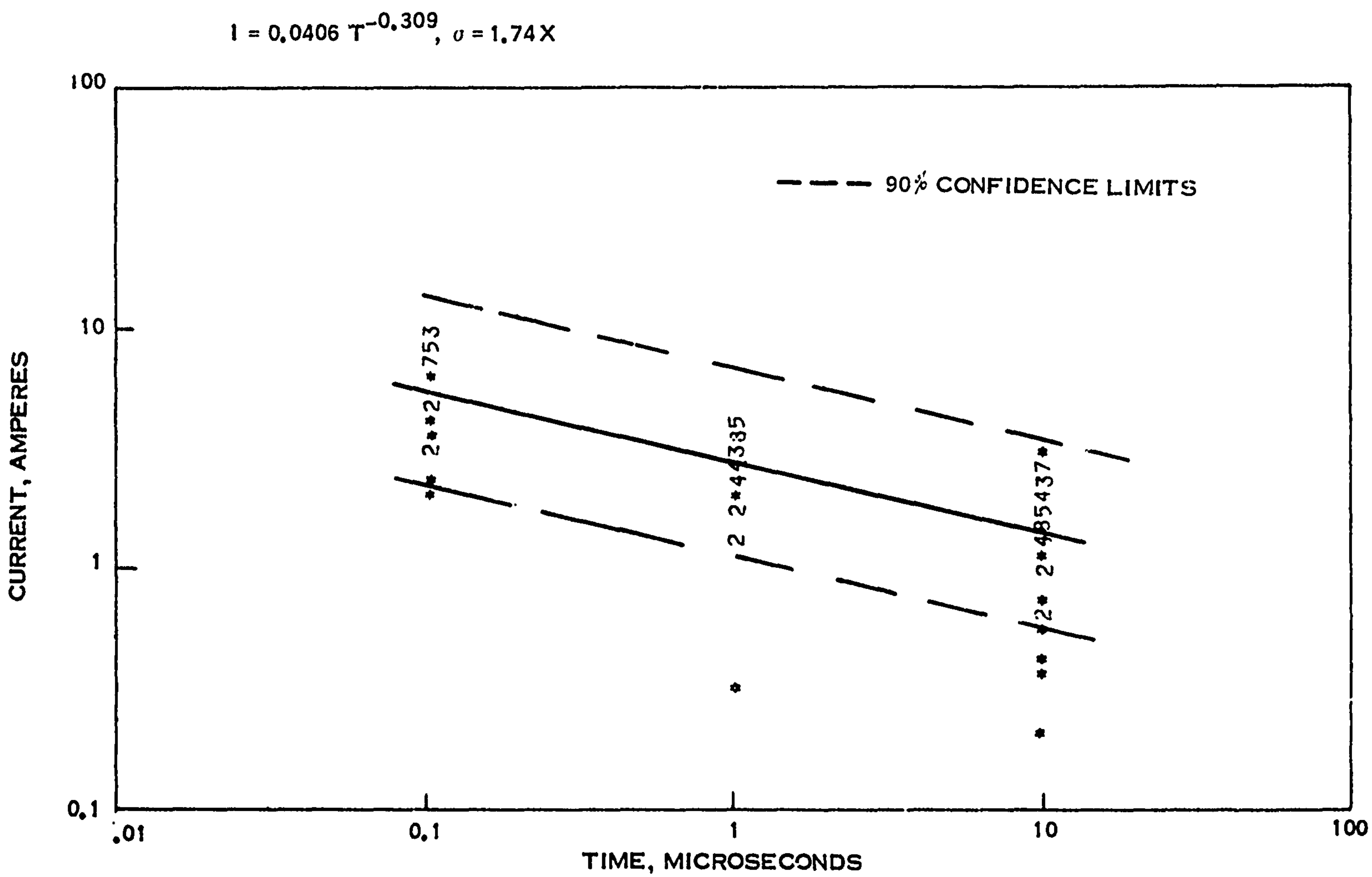


Figure 15. Power Supply Current Failure Model for RTL Devices

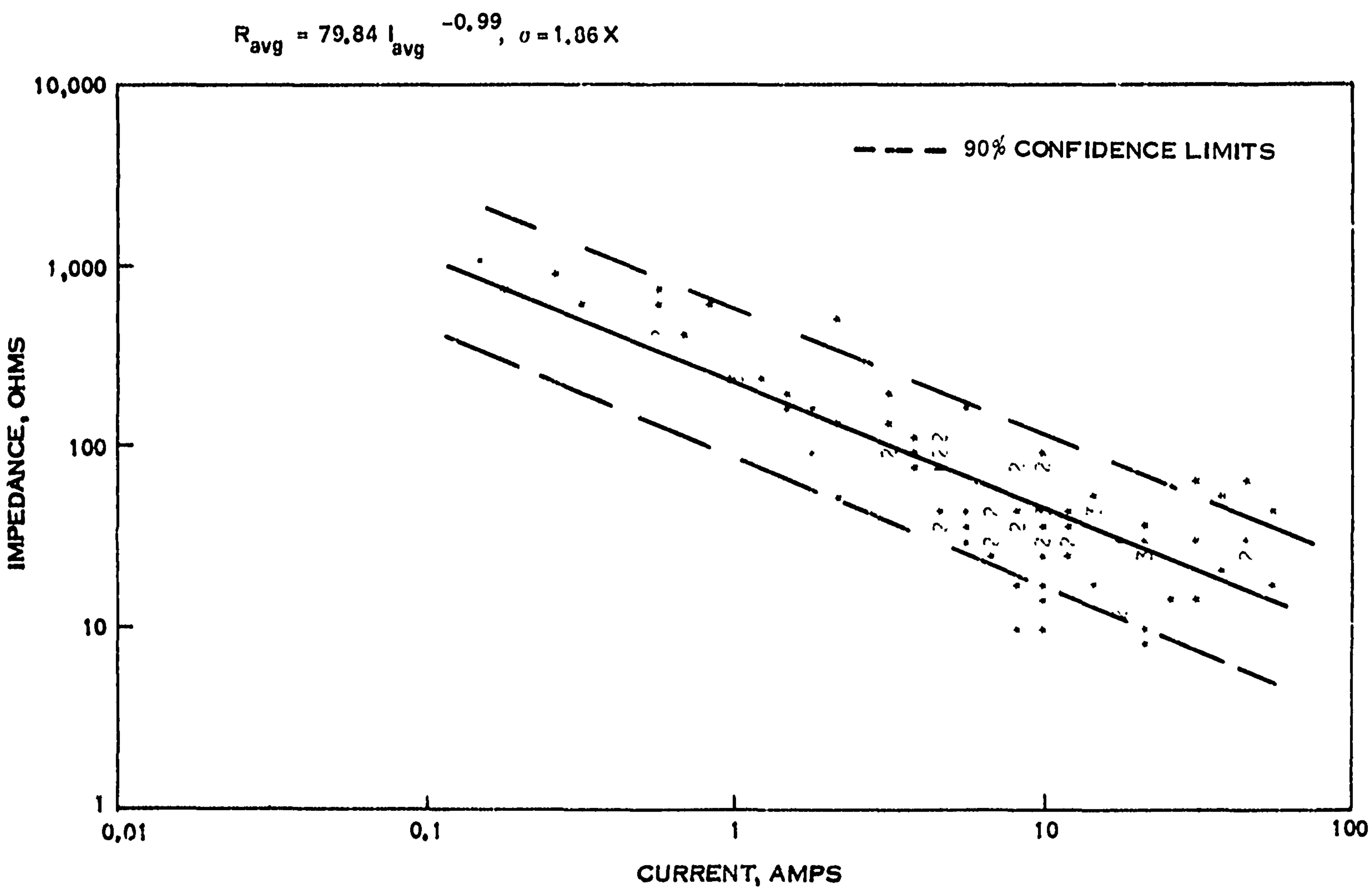


Figure 16. Input Impedance Model for RTL Devices

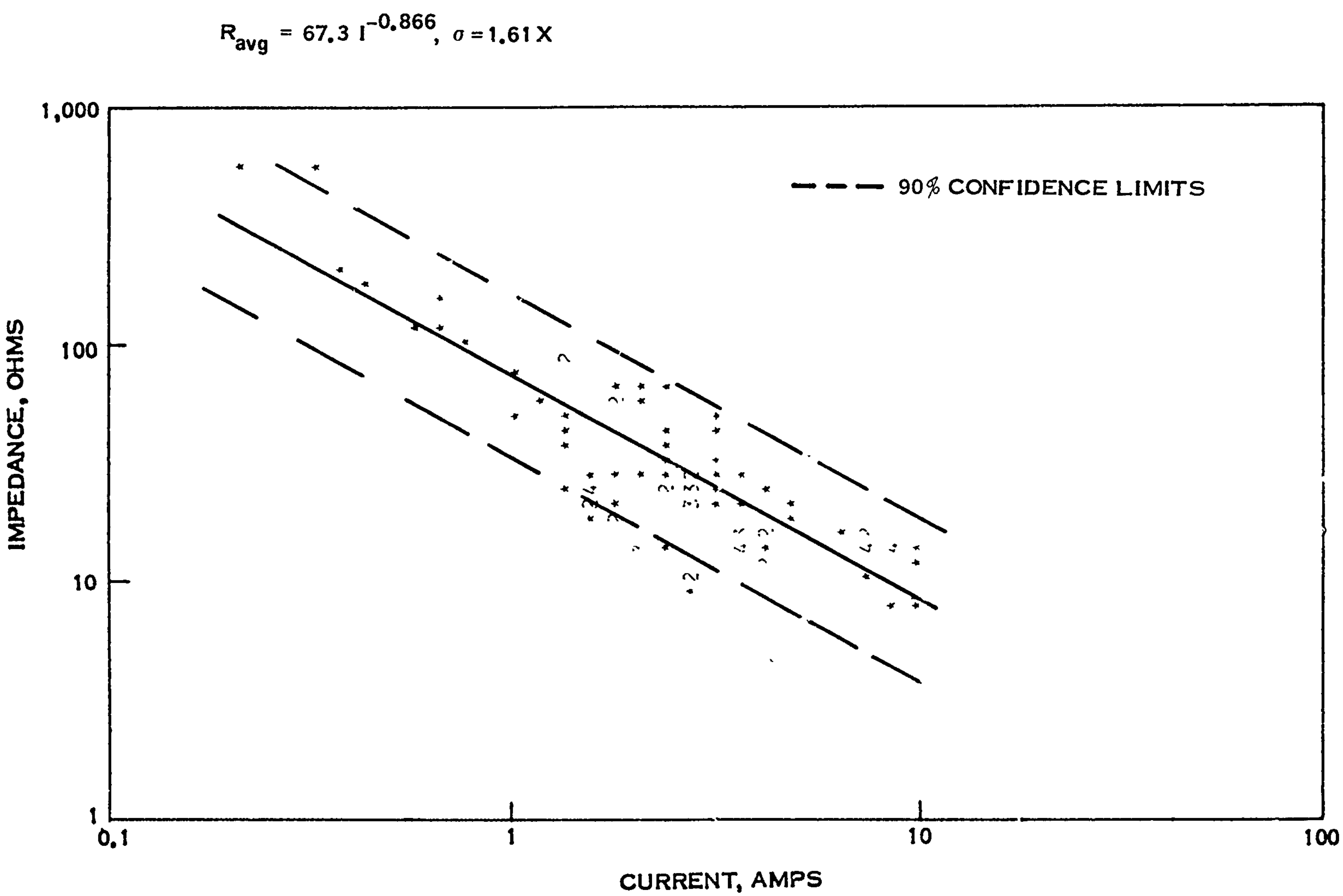


Figure 17. Power Supply Impedance Model for RTL Devices

$P = 2.7 \times 10^{8}\ tpd^{1.39}\ P^{0.88}\ t^{-0.45},\ \sigma = 1.73X$

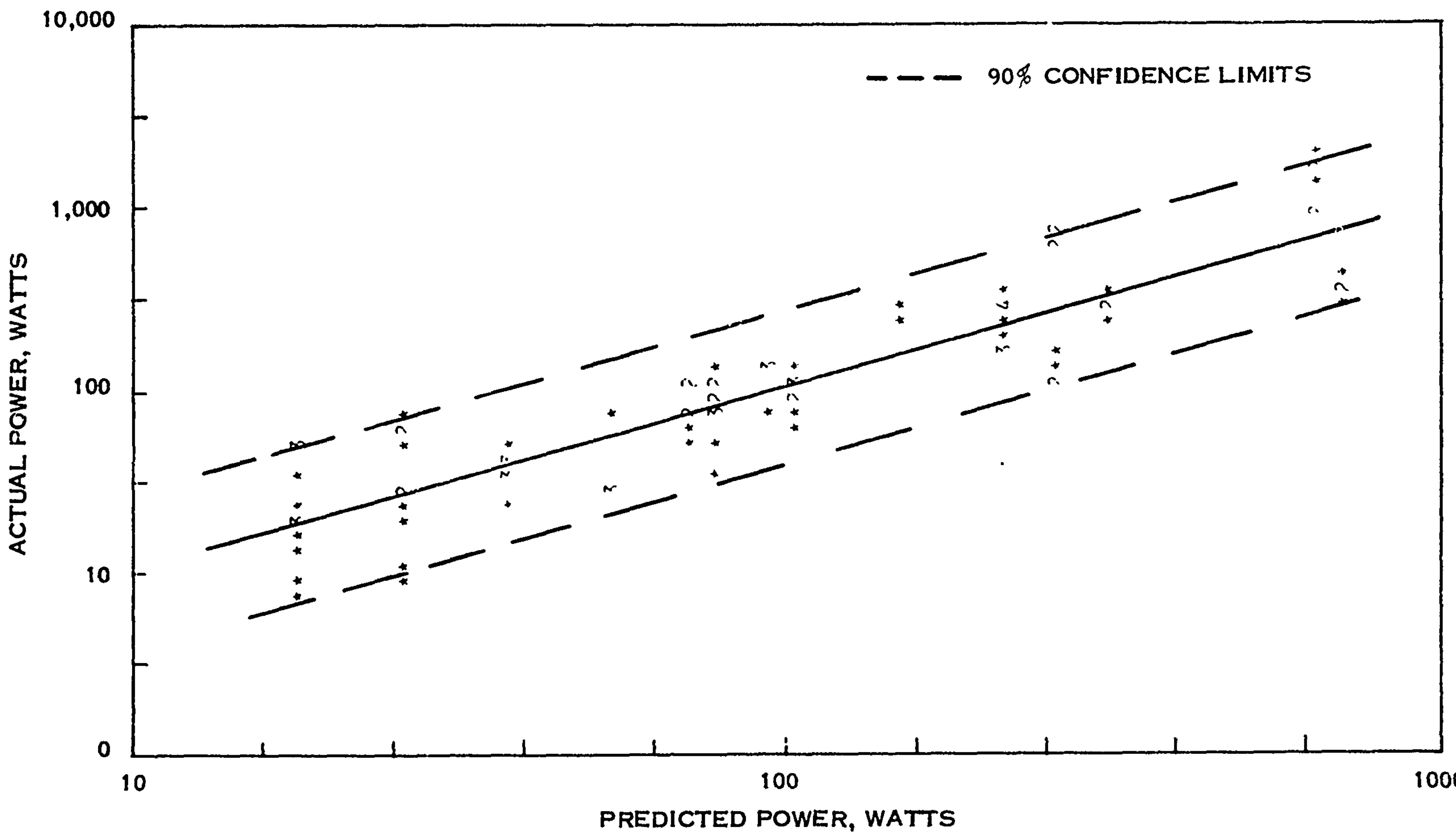


Figure 18. RTL Input Power Failure Model Including Electrical Parameters

correlation; however, there was insufficient data to adequately assess the relationship between the power failure threshold and the thermal resistances.

5.2.3) DIODE-TRANSISTOR LOGIC MODELS (DTL)

A rather extensive data base exists for this family of devices. For instance, there are 506 data points for the input power failure threshold. Table 15 summarizes the basic (power, current, and impedance) models that were generated for this category. Excellent models in terms of low standard deviation (<2X) were obtained for the current failure models. This low standard deviation was surprising because of the large variability in terms of manufacturers and construction type that was found in the parts types of this category. Typical power, current and impedance models are shown in Figures 19-23.

For all of the DTL models, data that were for pulse widths above 1 microsecond, were eliminated. The power or current versus pulse width begins to change above 10 microseconds as heat is conducted away from the junction being stressed. Since the time period of greatest interest was from 10 nanoseconds to 1 microsecond, this longer pulse width data were not used.

The effects of construction type and junction isolation versus dielectric isolation, were also investigated for this family of devices. No devices with thin film resistors were identified in the data bank. Figure 24 shows the comparison of dielectrically isolated devices versus junction isolated devices for the power failure threshold of the input to ground terminal. The dielectrically isolated devices appear to be more susceptible at pulse widths of 1 to 10 microseconds than junction isolated devices. This type of result was not unexpected as the isolation technique could cause different heat transfer properties of a device which would be manifested at the longer pulse widths. At the shorter pulse width the energy during a pulse does not have sufficient time to dissipate and hence the heat transfer properties of the isolation technique would not affect the pulsed power threshold at short pulse widths. However, the data base for the dielectrically isolated devices was really not as good as it appears to be because 164 of the 189 data points came from just two different device types. Also, the device types for the two different classes (dielectric and junction isolated) were not necessarily the same. Because of this, definite conclusions could not be drawn from the available data. Unfortunately there was insufficient data to generate any meaningful models for either the output or power terminals of dielectrically isolated devices.

The generation of failure models based on different families of devices was based on the expectation that similarly

Table 15. Summary of DTL Models

Model	Input	σ	# Points	# Types	Output	σ	# Points	# Types	Power	σ	# Points	# Types
P_{avg}*	$P = 0.088\ t^{-0.44}$	2.5X	506	30	$P = 0.0065\ t^{-0.69}$	2.1X	305	22	$P = 0.093\ t^{-0.55}$	2.4X	178	16
I_{avg}*	$I = 0.0072\ t^{-0.37}$	1.9X	492	27	$I = 0.008\ t^{-0.12}$	1.8X	293	20	$I = 0.022\ t^{-0.35}$	2.0X	178	16
R_{avg}	$R = 28.85\ I^{-0.84}$	2.0X	543	27	$R = 26.6\ I^{-0.73}$	2.4X	293	20	$R = 51.5\ I^{-0.75}$	1.9X	178	16

*$t \leq 10\ \mu$sec only

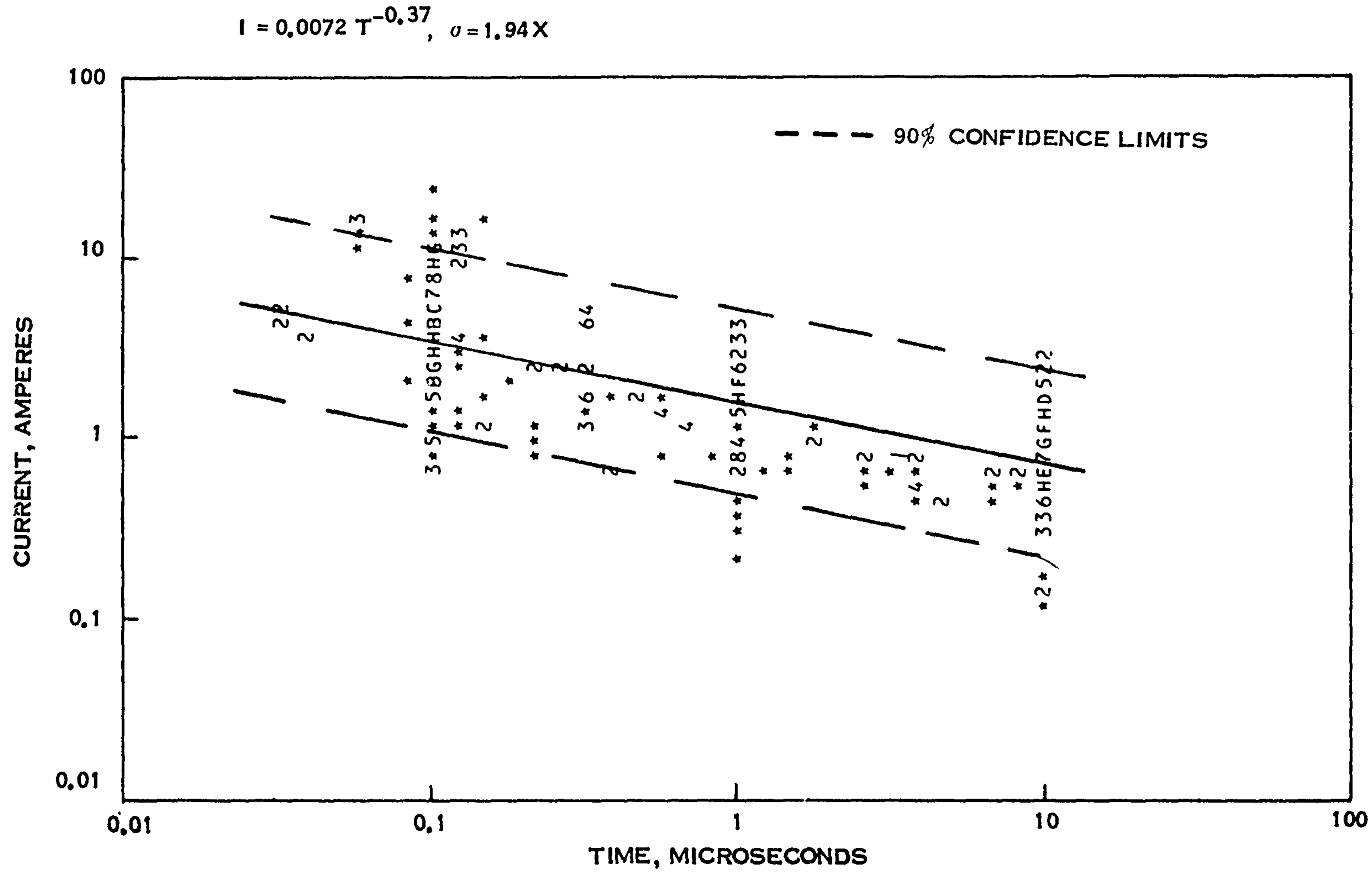


Figure 19. Input Current Failure Models for DTL Devices

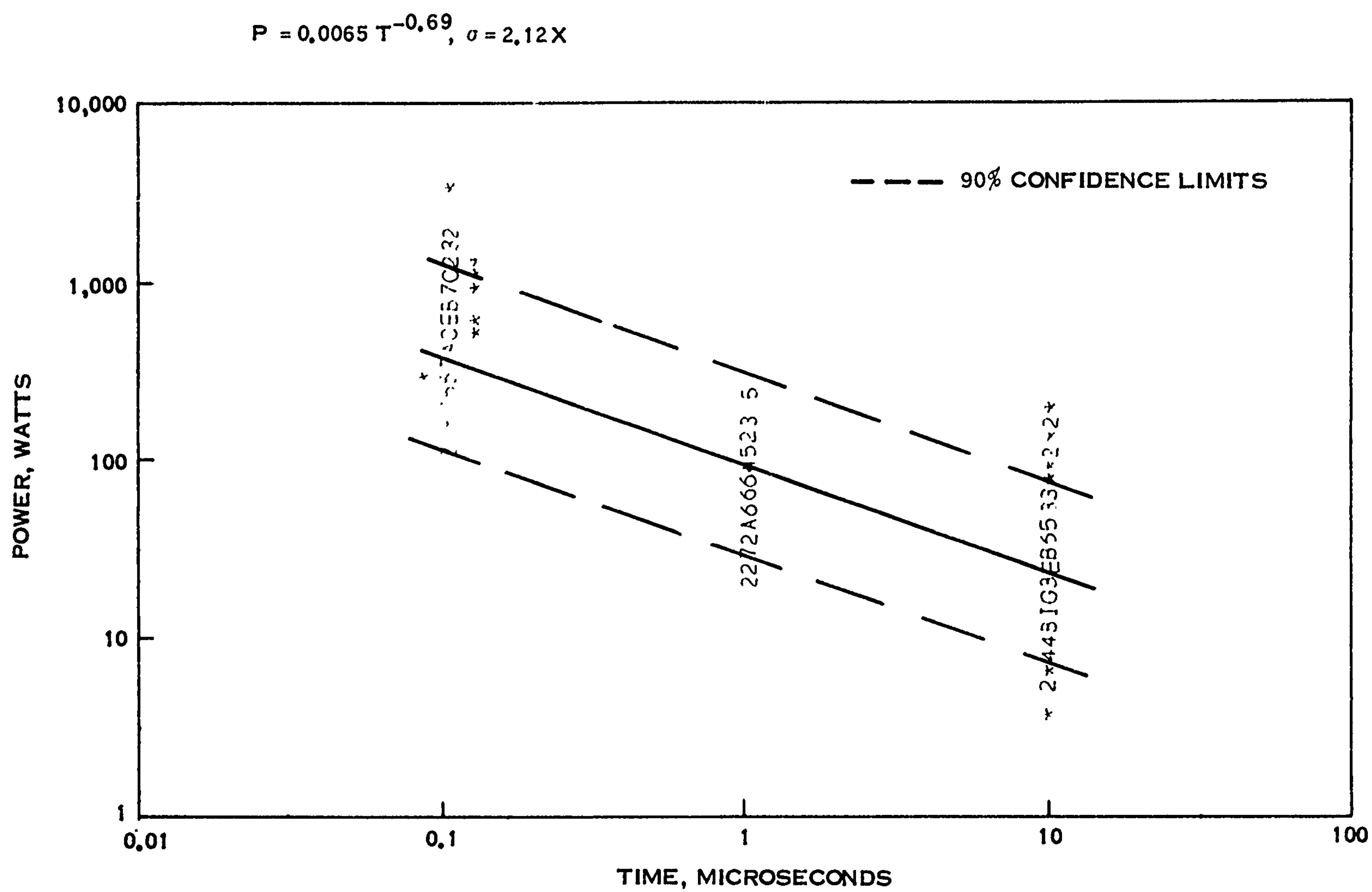


Figure 20. Output Power Failure Model for DTL Devices

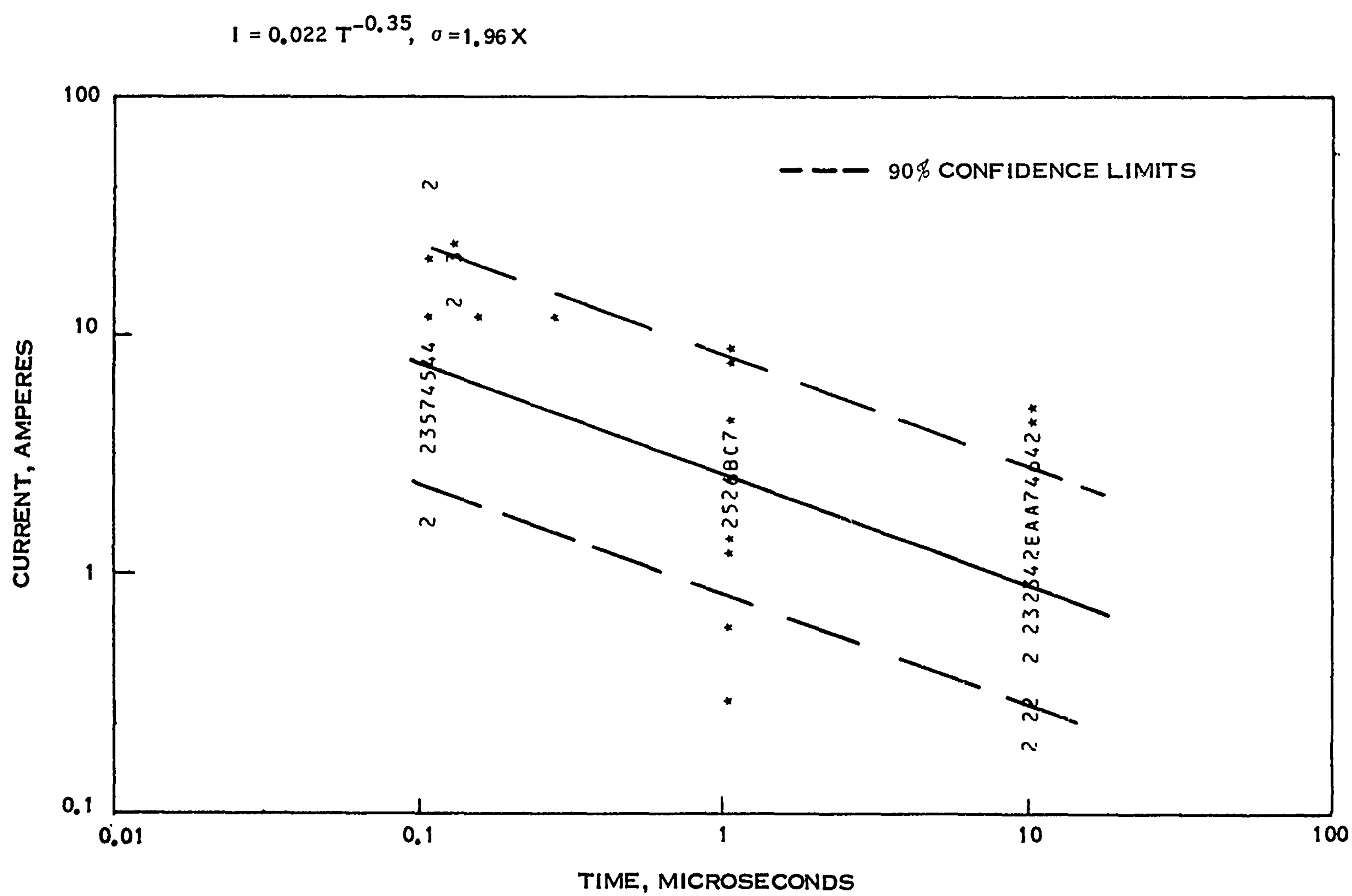


Figure 21. Power Supply Current Failure Model for DTL Devices

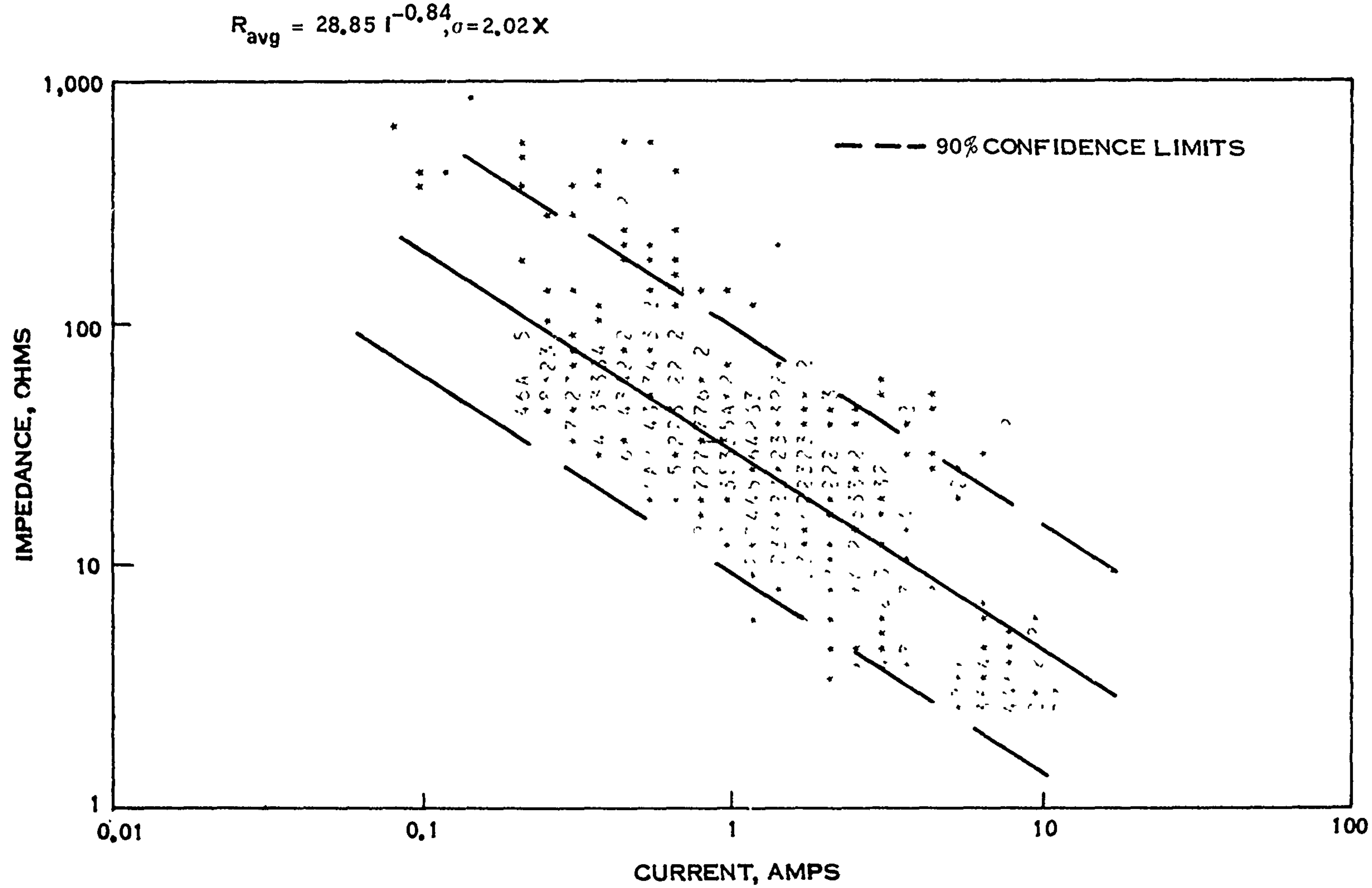


Figure 22. Input Impedance Model for DTL Devices

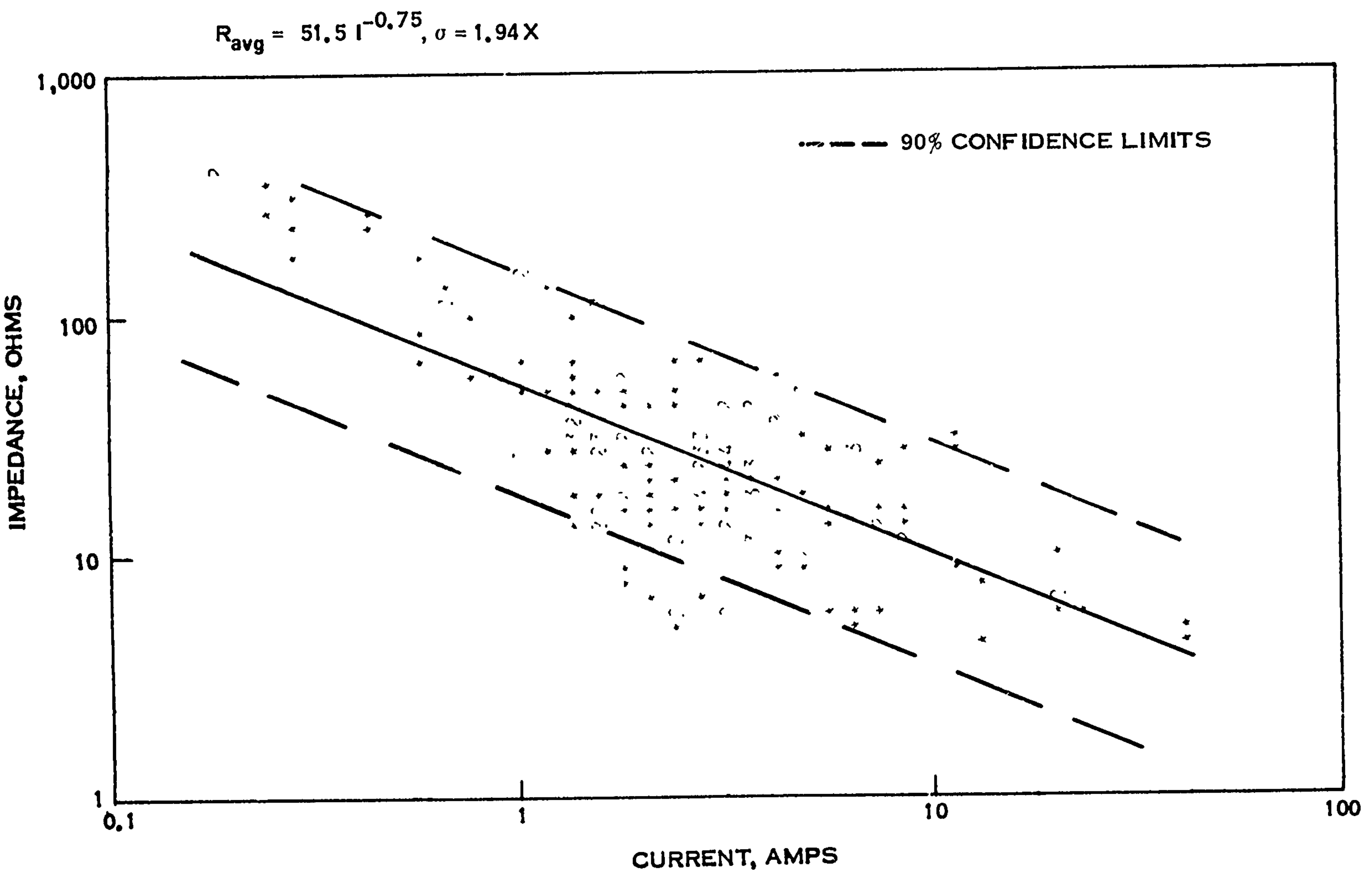


Figure 23. Power Supply Impedance Model for DTL Devices

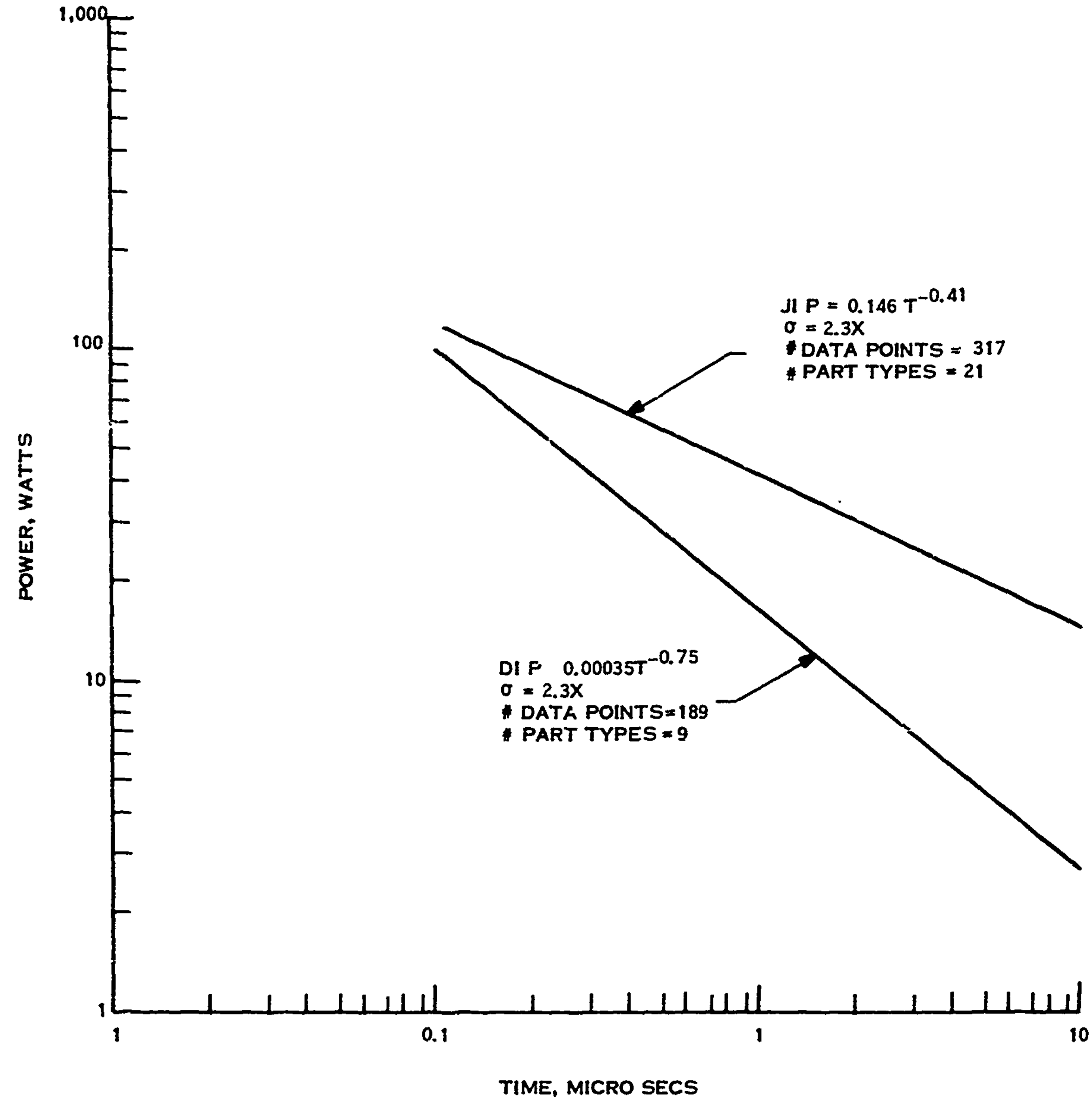


Figure 24. Comparison of the Input-Ground Power Failure Thresholds for Dielectric (DI) Versus Junction Isolated (JI) DTL Devic s

designed devices would have similar pulse power responses. In order for this to be true a device from one manufacturer must behave like a similar device from another manufacturer. In order to assess this variability, the effects of different manufacturers were investigated. A fairly large amount of data existed for three different semiconductor manufacturers. These manufacturers were Fairchild (FSC), Motorola (MOT) and National (NSC). In addition, for the input terminal there was also a significant amount of data for Radiation Inc. devices. The device types for which data existed were generally not the same for the different manufacturers, consequently, models were made for all devices made by a single manufacturer grouped together. These models were then compared to one another. Figure 25 shows this comparison for the four different manufacturers for the input to ground power failure threshold. The comparison of the current failure threshold results in similar graphs. Figure 26 shows this comparison for three different manufacturers for the output to ground power failure threshold. In Figure 25 it should be noted that the RAD (Radiation Inc.) devices were the dielectrically isolated device that appeared to be more susceptible than the junction isolated devices. In both comparisons the NSC and FSC devices showed almost identical pulse power response characteristics while the MOT (Motorola) devices in this sample appeared to be more vulnerable for the input terminal yet less vulnerable for the output terminal. The average variability between different manufacturers of junction isolated devices appears to be about a factor of 2.5. Of course, individual devices may have a larger variability than this. The average effect of different manufacturers did not appear to cause a large spread in the models generated for this category of devices. These effects were within the 90% tolerance limits for the model of the category.

Regression analyses for the power failure threshold versus the different electrical parameters of the devices in this category were also performed. However, none of the electrical parameters improved the nominal power versus time model significantly. Some of the parameters which showed significant correlation for other categories of devices, did not have sufficient spread to yield meaningful results for DTL devices. These parameters were the thermal resistance and the terminal breakdown voltage (input only).

5.2.4) TRANSISTOR-TRANSISTOR LOGIC (TTL) MODELS

Currently, the most widely used circuit family is transistor-transistor logic. This high performance bipolar digital logic family comprises five distinct sub-families or series. These sub-families offer optimization of the basic TTL for either speed, power consumption or both. The five sub-families along with their typical speed (propagation delay time) and power dissipation are shown in Table 16.

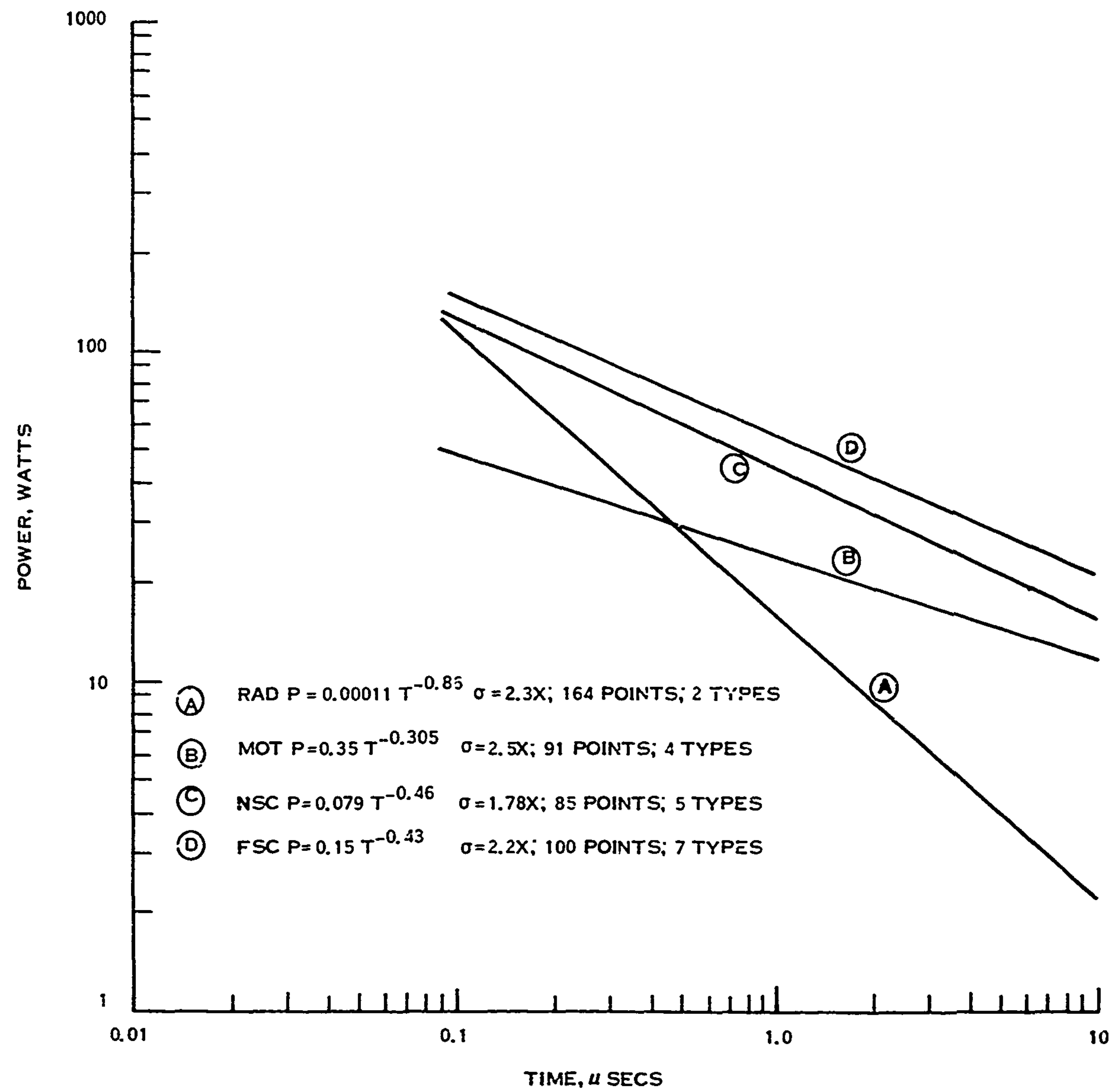


Figure 25. Comparison of the Input-Ground Power Failure Thresholds for Different Manufacturers of DTL Devices

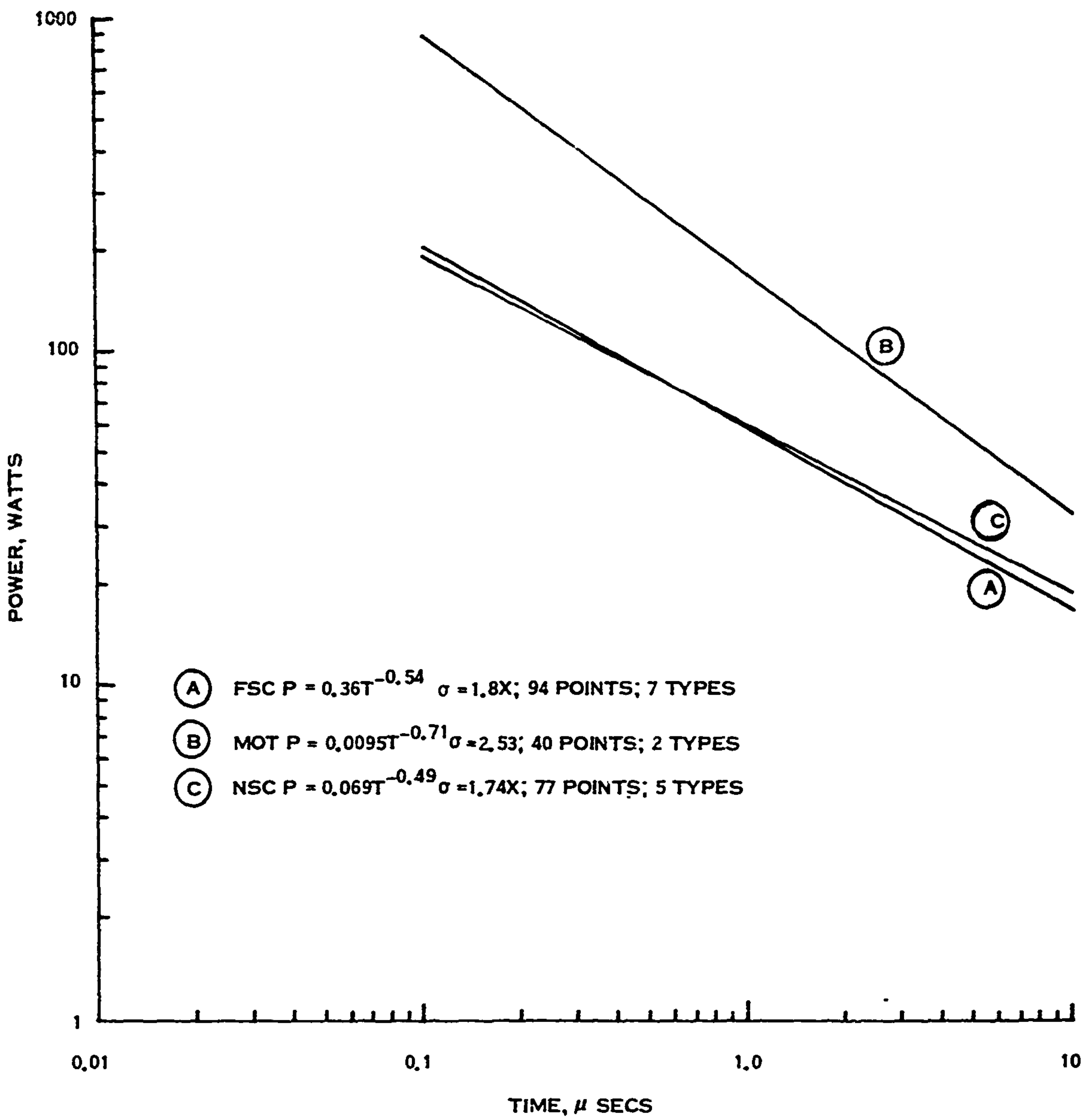


Figure 26. Comparison of the Output-Ground Power Failure Thresholds for Different Manufacturers of DTL Devices

TABLE 16
Typical Performance Characteristics of Different TTL Families

Series	Gates	
	Propagation Delay Time, ns	Power Dissipation, mW
Low Power Schottky	9.5	15
Low Power	33	1
Schottky	3	19
Standard	10	10
High Speed	6	22

Different models have been generated for each of the sub-families as well as an overall TTL model. Table 17 tabulates the models that have been generated. Figures 27, 28, and 29 show a comparison of the nominal models for the different TTL families for the input, output and power supply power failure thresholds respectively. As can be seen from the graphs the relative susceptibility of the different TTL families changed with the terminal being considered and occasionally with the time period of interest. For instance, the most susceptible family to damage of its input terminal for times less than about 1 microsecond is the High Speed TTL. However, for times greater than about 1 microsecond, the Schottky and Low Power Schottky appeared to be more susceptible to damage. For the power supply terminal, the Low Power devices are least susceptible, as it might have been expected, because of the protection afforded by the higher values of resistance in this design. The variability from strongest to weakest is about 3 to 1 for the input terminal and 4 to 1 for the output terminal. The relative susceptibility of the various TTL sub-families was not as would be expected based on the typical performance characteristics as shown in Table 16. One would intuitively expect the lower power dissipation devices and the lower propagation delay time devices to be the more susceptible devices to pulse power overstress, however this was not the case. The low power TTL devices were among the hardest to damage, while the high speed were generally the easiest to damage. The hardness of the low power devices might be attributable to the higher values of resistance that are used in this design as shown in Figure 10. The low power Schottky TTL appears to be more susceptible than of the regular Schottky TTL, since only a small amount of data is available for this type of device strong conclusions should not be drawn. The low power Schottky devices exhibited a constant impedance at high injection levels that was quite low in comparison with the other classes of TTL devices. This is probably caused by the Schottky barrier junctions that are used in the construction of this type of device. Thus, whenever high accuracy models are required it will be

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Table 17. Summary of TTL Models

Model	Input	σ	# Points	# Types	Output *	σ	# Points	# Types	Power	σ	# Points	# Types
A[illegible] TL												
[illegible]avg	$P = 0.00036\ t^{-0.87}$	3.3X	571	39	$P = 0.0186\ t^{-0.61}$	2.6X	397	28	$P = 0.0021\ t^{-0.87}$	[illegible]	177	14
I_{avg}	$I = 0.00134\ t^{-0.53}$	2.3X	532	32	$I = 0.031\ t^{-0.35}$	1.9X	393	27	$I = 0.0096\ t^{-0.[illegible]}$	[illegible]	177	13
R_{avg}	$R = 25.5\ I^{-0.5}$	2.0X	531	32	$R = 10.7\ I^{-0.44}$	1.8X	393	27	$R = 15.7\ I^{-0.3[illegible]}$	[illegible]	175	13
Standard TTL												
P_{avg}	$P = 0.012\ t^{-0.61}$	2.4X	232	13	$P = 0.0092\ t^{-0.69}$	2.4X	207	13	$P = 0.00017\ t^{-[illegible].0}$	2.1X	[illegible]	4
I_{avg}	$I = 0.018\ t^{-0.32}$	2.0X	216	13	$I = 0.0175\ t^{-0.41}$	2.0X	203	13	$I = 0.00[illegible]2\ t^{-0.61}$	1.8X	74	4
R_{avg}	$R = 28.6\ I^{-0.45}$	1.7X	216	13	$R = 12.7\ I^{-0.53}$	1.6X	203	13	$R = 18\ I^{-0.44}$	1.5X	74	4
High Speed TTL												
P_{avg}	$P = 0.02\ t^{-0.5}$	2.3X	66	4	$P = 0.13\ t^{-0.43}$	1.4X	16	2	Insufficient Data			
I_{avg}	$I = 0.015\ t^{-0.32}$	1.7X	66	4	$I = 0.1\ t^{-0.23}$	1.5X	16	2	Insufficient Data			
	$R = 17.7\ I^{-0.57}$	1.6X	66	4	$R = 8$	2.0X	16	2				
Low Power TTL												
P_{avg}	$P = 2.6 \times 10^{-4}\ t^{-0.9}$	3.5X	140	12	$P = 0.013\ t^{-0.60}$	2.4X	43	5	$P = 0.027\ t^{-0.73}$	2.5X	23	4
I_{avg}	$I = 0.001\ t^{-0.55}$	2.0X	116	8	$I = 0.02\ t^{-0.35}$	1.8X	43	5	$I = 0.029\ t^{-0.42}$	1.8X	23	4
R_{avg}	$R = 35.3\ I^{-0.18}$	1.4X	116	8	$R = 15.5\ I^{-0.53}$	1.9X	43	5	$R = 14.2\ I^{-0.3}$	1.8X	23	4
Schottky TTL												
P_{avg}	$P = 0.1 \times 10^{-4}\ t^{-1.1}$	4.2X	39	2	$P = 0.0029\ t^{-0.7}$	2.5X	43	2	$P = 0.0021\ t^{-0.87}$	2.5X	32	2
I_{avg}	$I = 0.00029\ t^{-0.66}$	3.5X	39	2	$I = 0.019\ t^{-0.37}$	1.3X	43	2	$I = 0.32\ t^{-0.28}$	1.7X	33	2
R_{avg}	$R = 18.3\ I^{-0.51}$	2.2X	39	2	$R = 7.1\ I^{-0.22}$	1.6X	43	2	$R = 3.2$	1.6X	32	2
Low Power Schottky P_{avg}	$P = 2.7 \times 10^{-5}\ t^{-1.0}$	2.7X	94	4	$P = 1.1 \times 10^{-4}\ t^{-0.91}$	2.4X	88	4	$P = 0.0026\ t^{-0.81}$	2.8X	44	2
I_{avg}	$I = 0.0041\ t^{-0.5}$	1.5X	95	4	$I = 0.0096\ t^{-0.42}$	1.44	88	[illegible]	$I = 0.036\ t^{-0.37}$	1.7X	45	2
R_{avg}	$R = 3.6$	2.2X	94	4	$R = 2.9$	1.8X	88	4	$R = 7.5$	1.8X	44	2
ALL TTL	$P = 0.12\ C^{1.7}\ t^{-1.02}$	2.38X	115	6								

* Devices with open-collector outputs are not included.

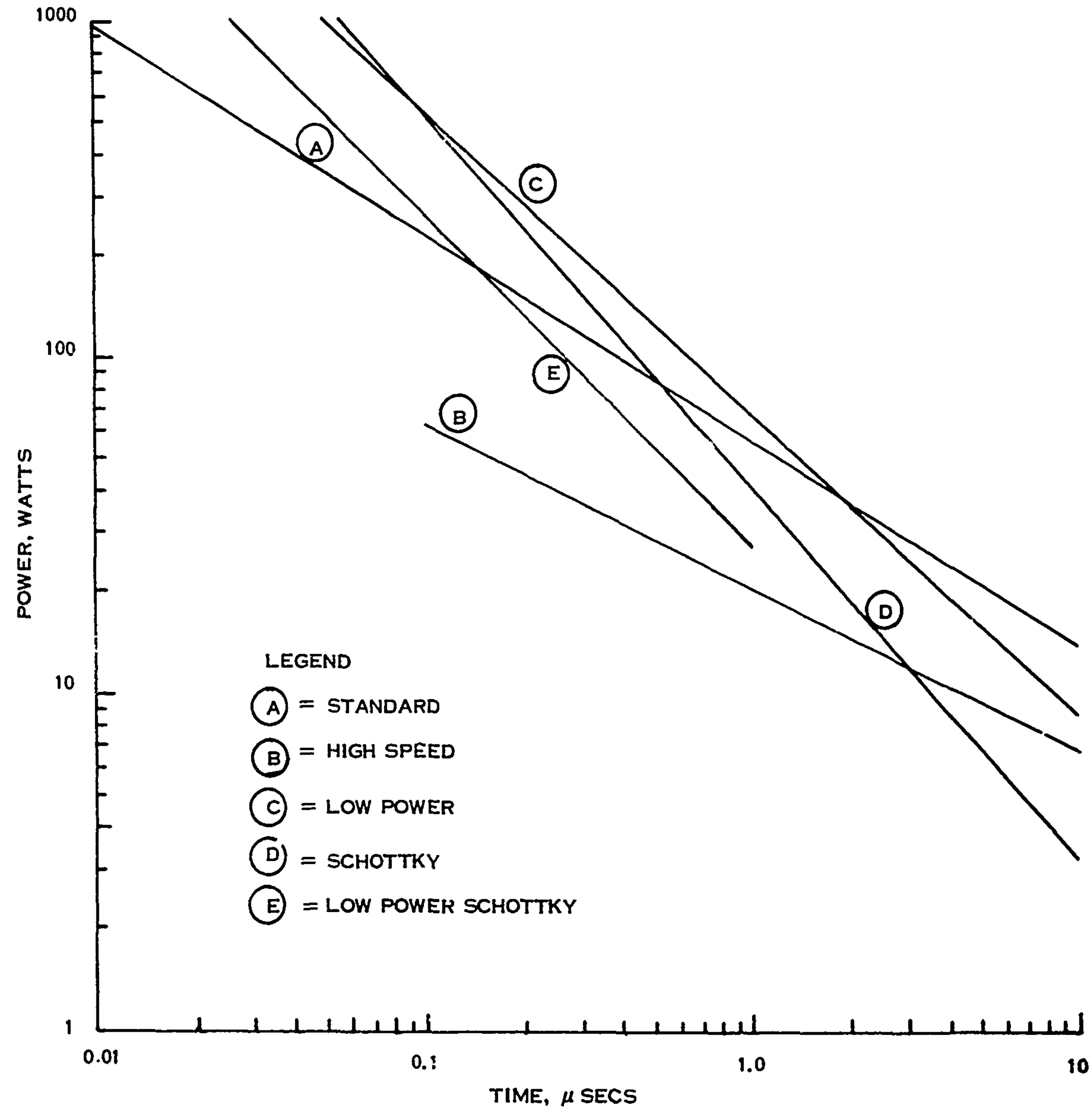

Figure 27. Comparison of the Input Power Failure Thresholds for Different TTL Families

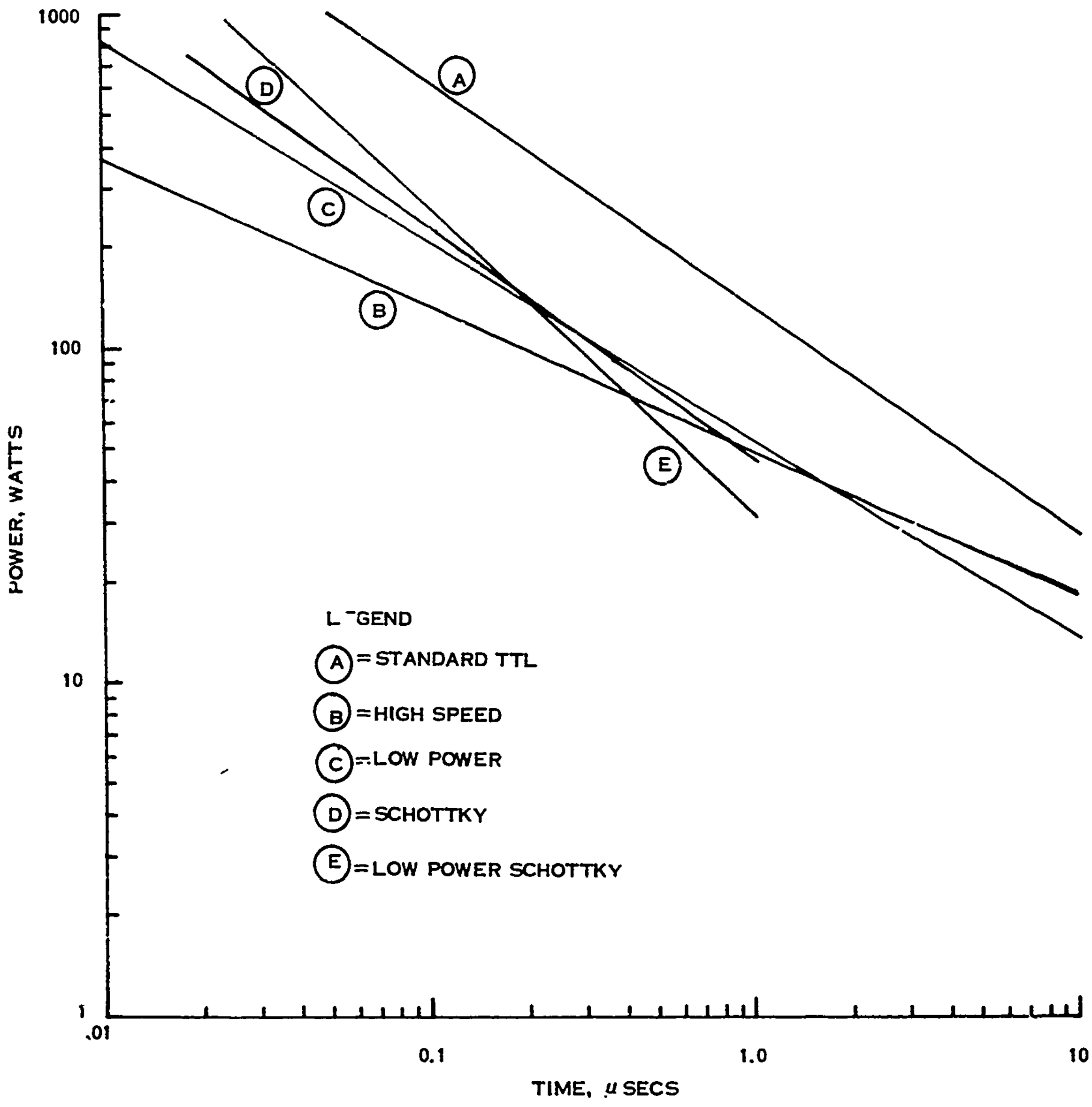

Figure 28. Comparison of the Output Power Failure Thresholds for Different TTL Families

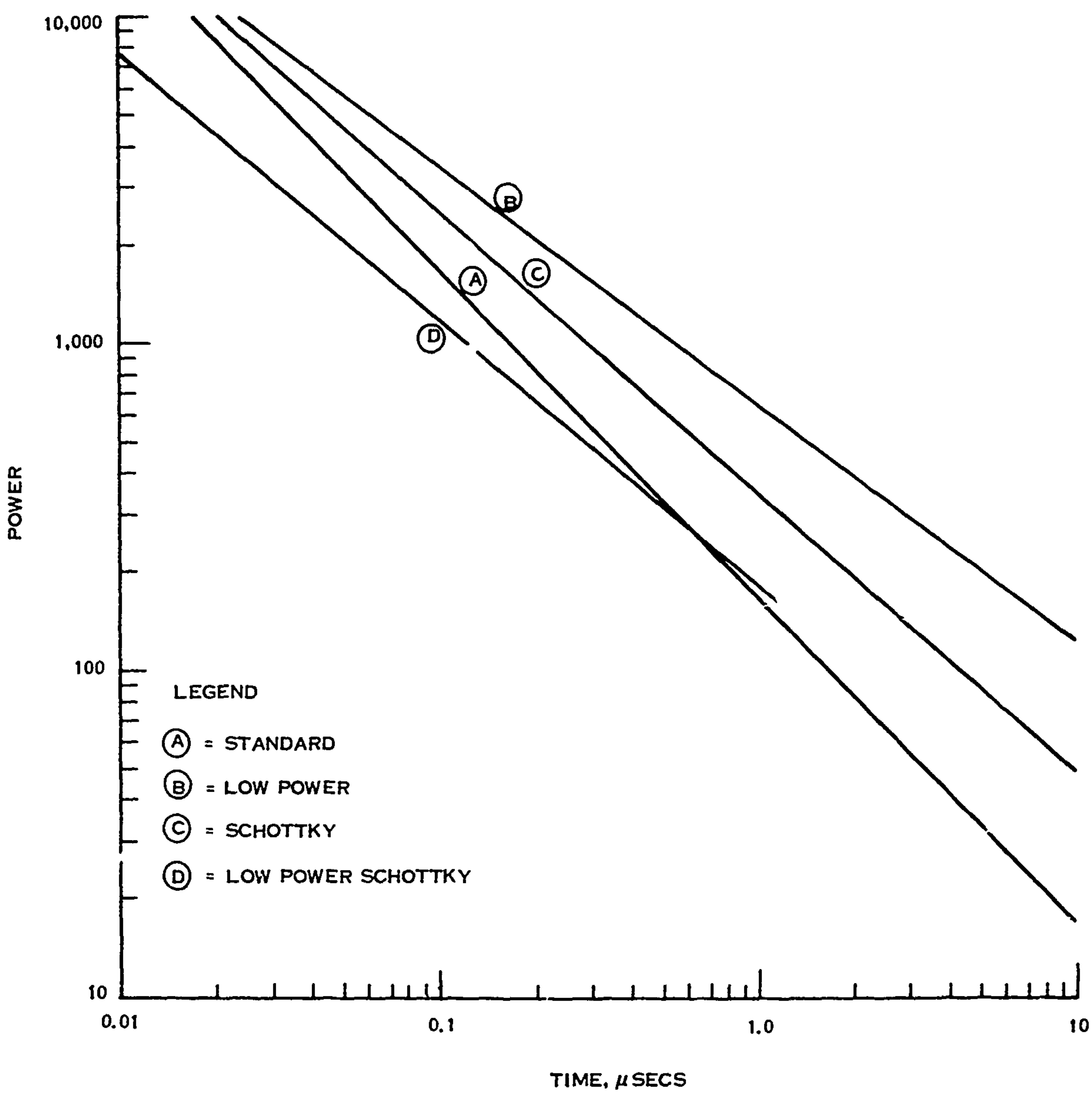

Figure 29. Comparison of Power Supply Power Failure Thresholds for Different TTL Families

necessary to subdivide the TTL family into its sub-families. Because of the large number of models that were generated, only typical results are shown in Figures 30 to 38 in order that the reader may obtain a "feel" for the data.

The effects of manufacturing differences could not be completely assessed because almost all of the data that exists is for devices made by Texas Instruments (TIX). Enough data existed to generate a model for standard TTL devices manufactured by Motorola, however, the results of this model were virtually identical to the model for standard TTL manufactured by TIX. A comparison made by Alexander and Durgin (reference 1) of a single part type (7400) made by three different manufacturers showed an order of magnitude difference in the input power threshold. Unfortunately, data for other part types from these three manufacturers are not available for comparison. The models for the low power Schottky class of TTL devices were based on test results on Texas Instrument devices only. This model might change significantly if another manufacturers parts were tested because the different manufacturers offer a low power Schottky device that is optimized in different ways. For instance, Fairchild offers faster AC specifications while American Micro Devices offers higher output drive capability (fan out). These differences may change the pulse power response characteristics of the same part type made by different manufacturers.

Models were also generated for power failure thresholds for the different terminals as a function of the electrical parameters of this family of devices. The results of this effort showed that the thermal resistance, breakdown voltage and the capacitance correlated with the power failure threshold. Of these three parameters, the thermal resistance and breakdown voltage, although showing some correlation, did not improve the sigma of the model enough (less than 5%) to warrant their inclusion. The capacitance showed the best correlation with the power failure model. The inclusion of this electrical parameter into the model reduced the sigma of the resulting model by about 10% over the nominal model and tabularized in Table 17. This model is shown in Figure 39. The capacitance values of the different TTL devices are shown in Table 18. These values were measured at zero volts dc bias with a one megahertz twenty-five millivolt AC signal. This correlation with capacitance was expected because the capacitance should give an indication of the junction area which is related to the power failure threshold. Similar regression analyses were performed for all of the TTL data independent of the terminal that was stressed with and without the terminal capacitance. This study showed that if the data was grouped in this manner, the overall sigma of a model of the power failure threshold as a function of time and capacitance resulted in a reduction in the model sigma to a factor of 3.11 from a

1. R. H. Vandre, "Pulse Power Burnout of Integrated Circuits", The Aerospace Corporation, TR-0073(3124)-1, SAMSO-TR-226, Aug. 1976

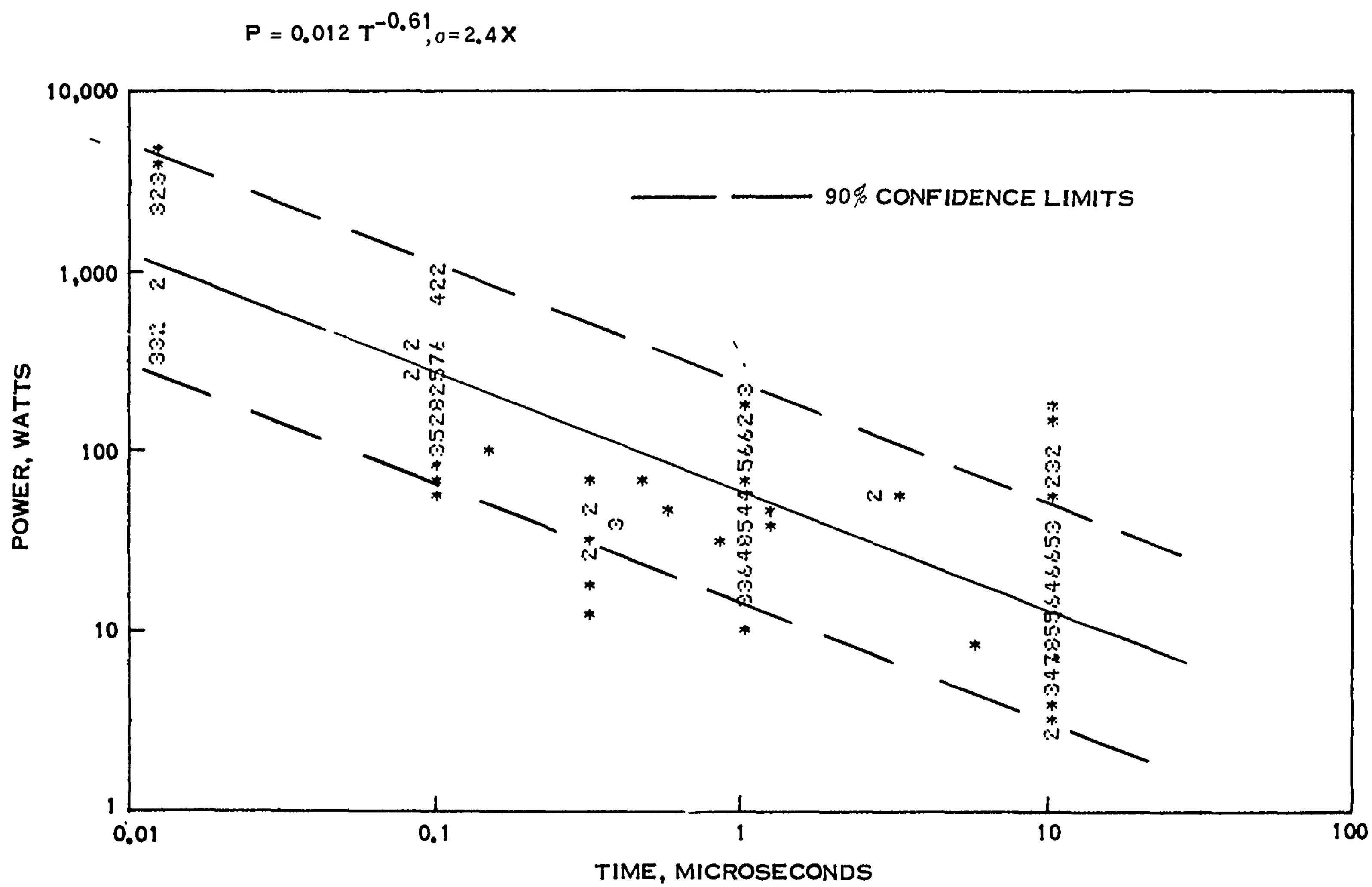

Figure 30. Input Power Failure Model for Standard TTL Devices

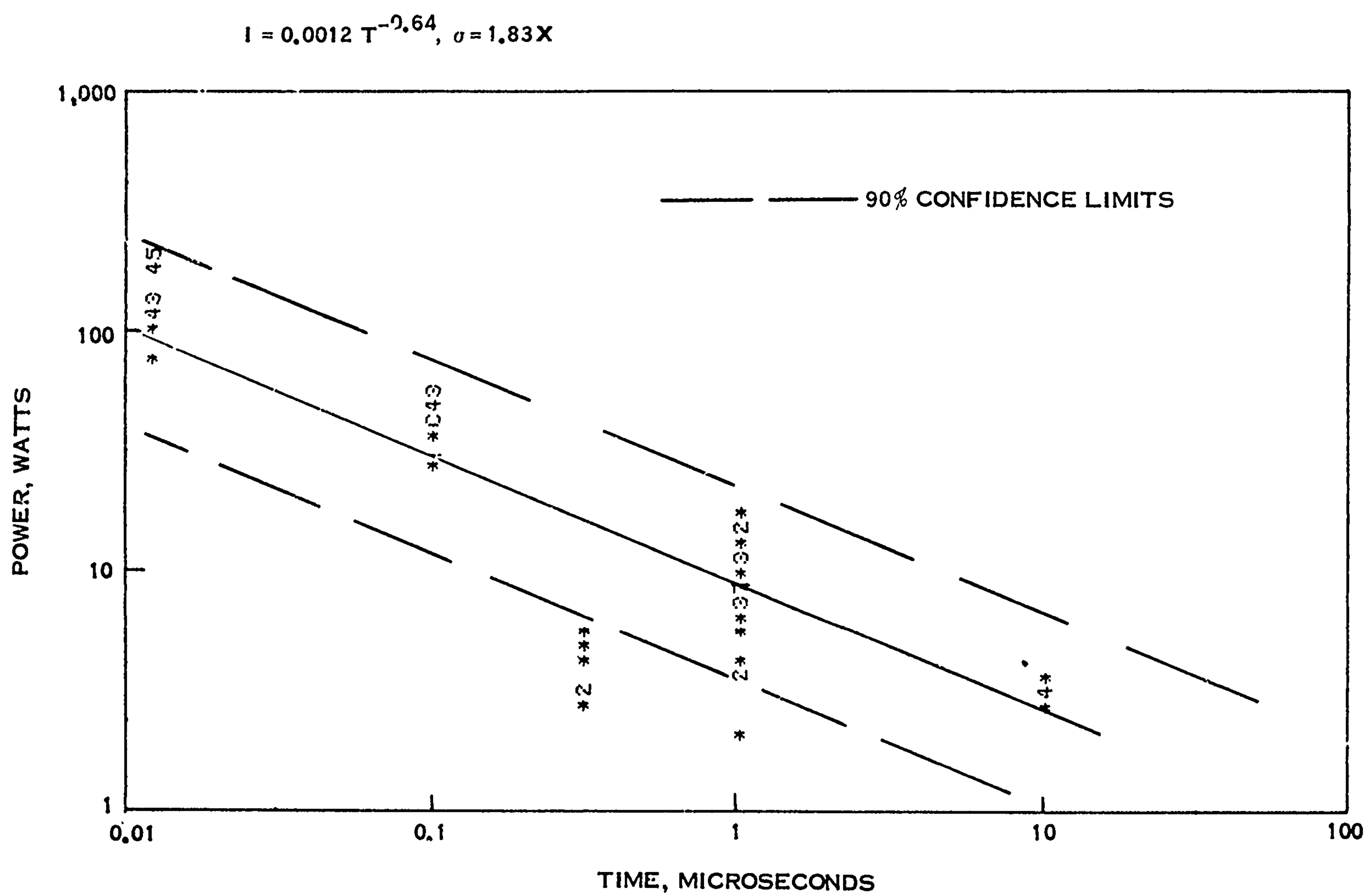

Figure 31. Power Supply Current Failure Model for Standard TTL Devices

$R = 12.66\ T^{-0.53}, \sigma = 1.6X$

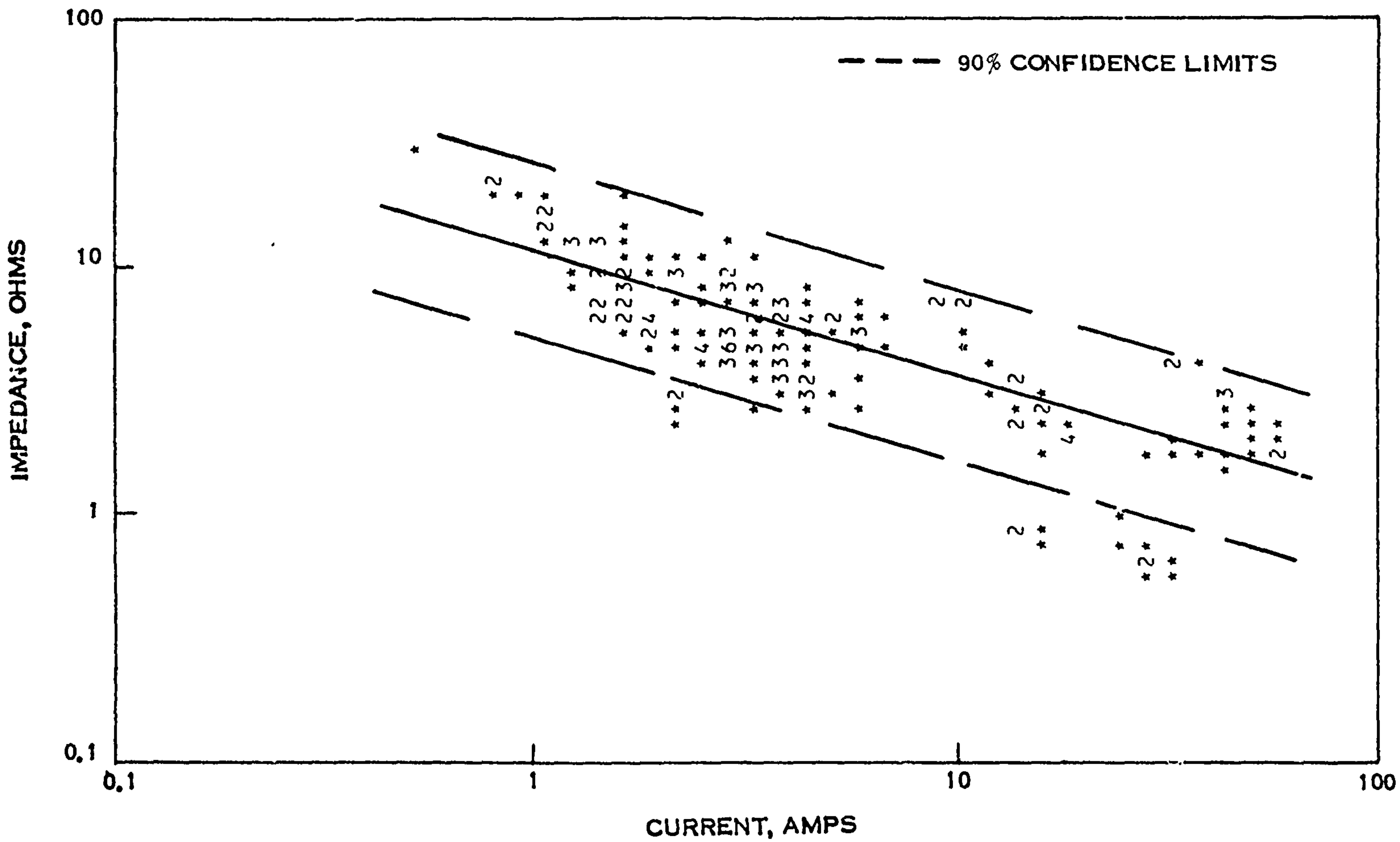

Figure 32. Output Impedance of Standard TTL Devices

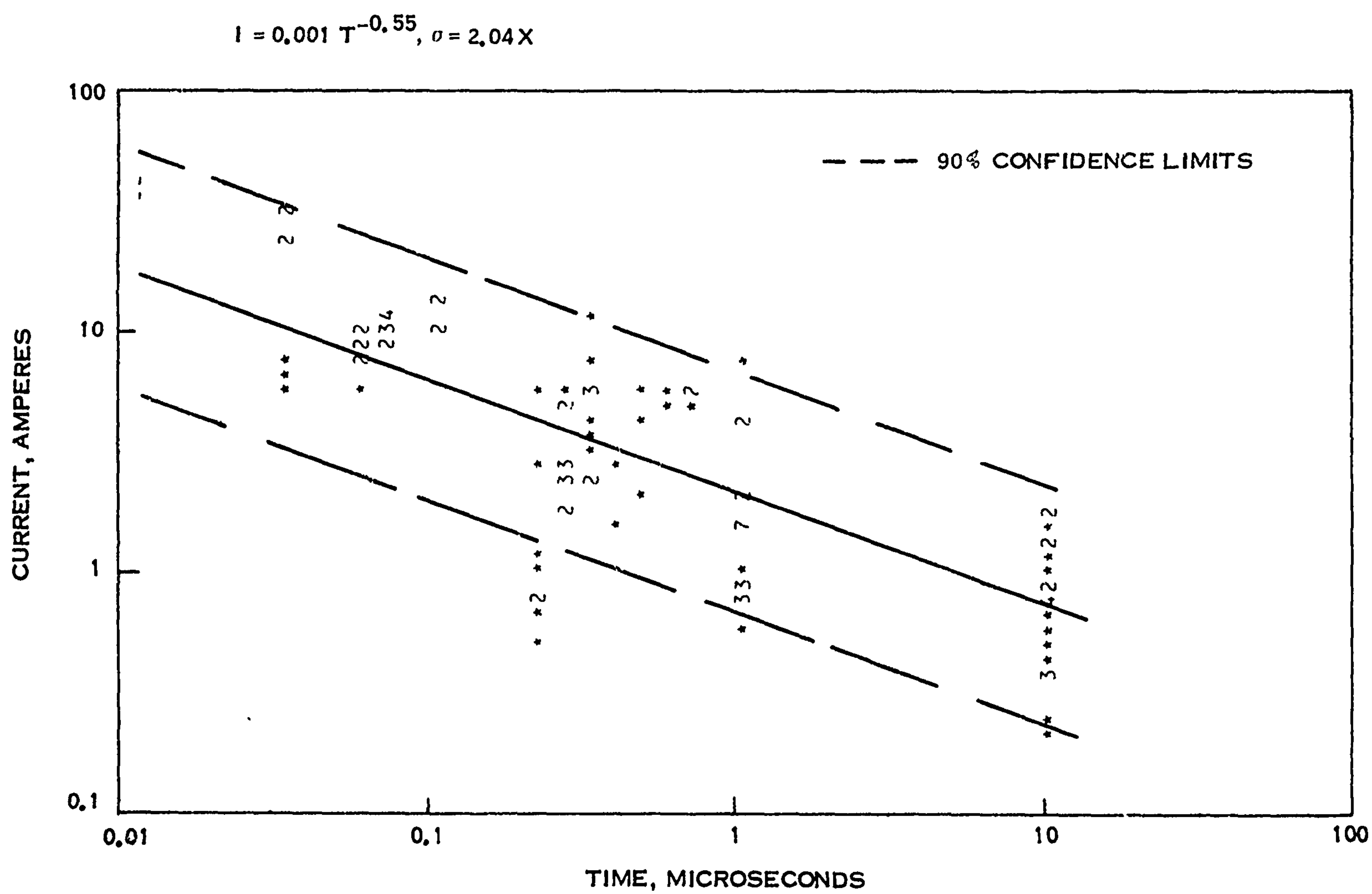

Figure 33. Input Current Failure Model for Low Power TTL Devices

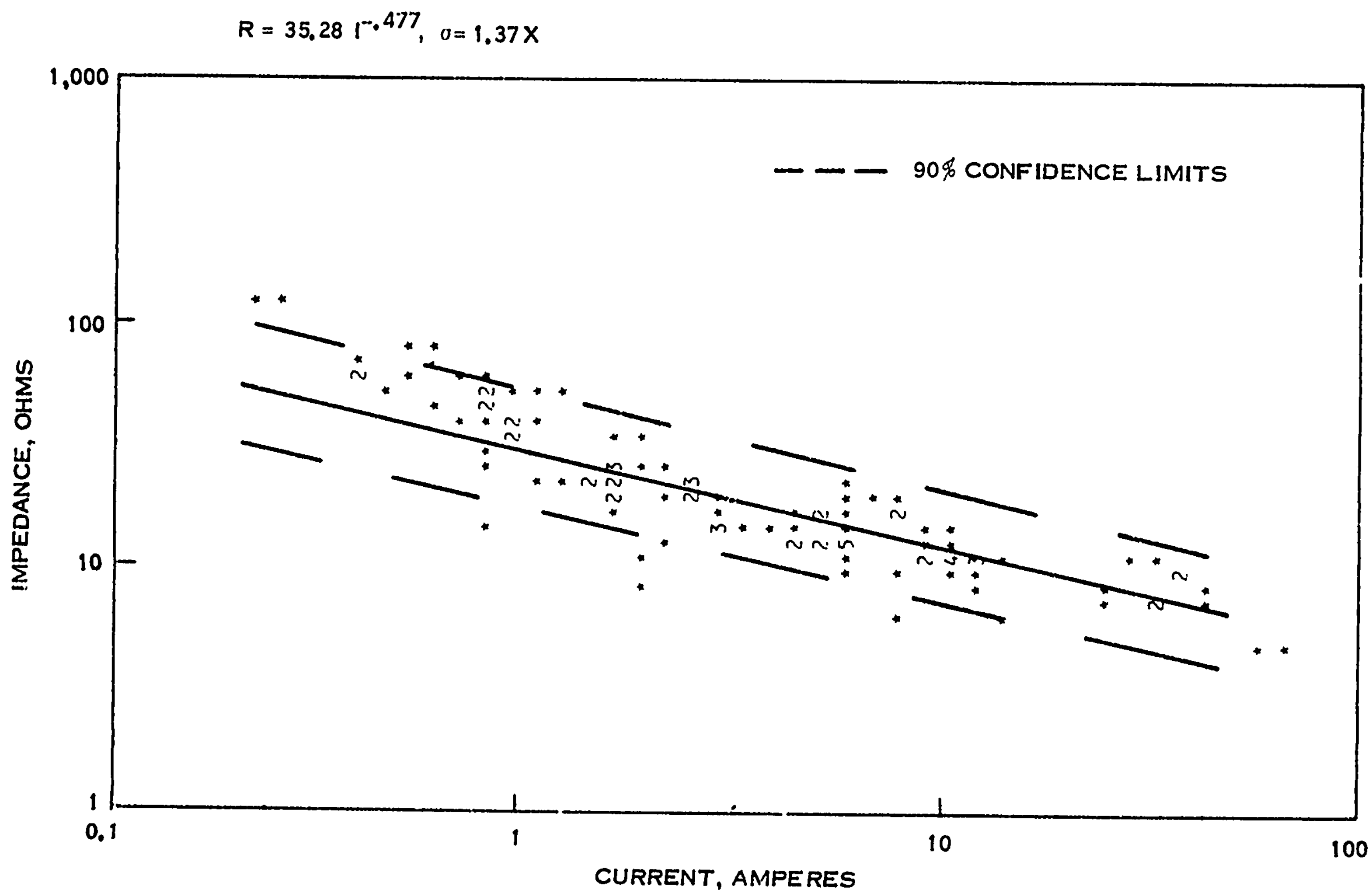

Figure 34. Input Impedance Model of Low Power TTL Devices

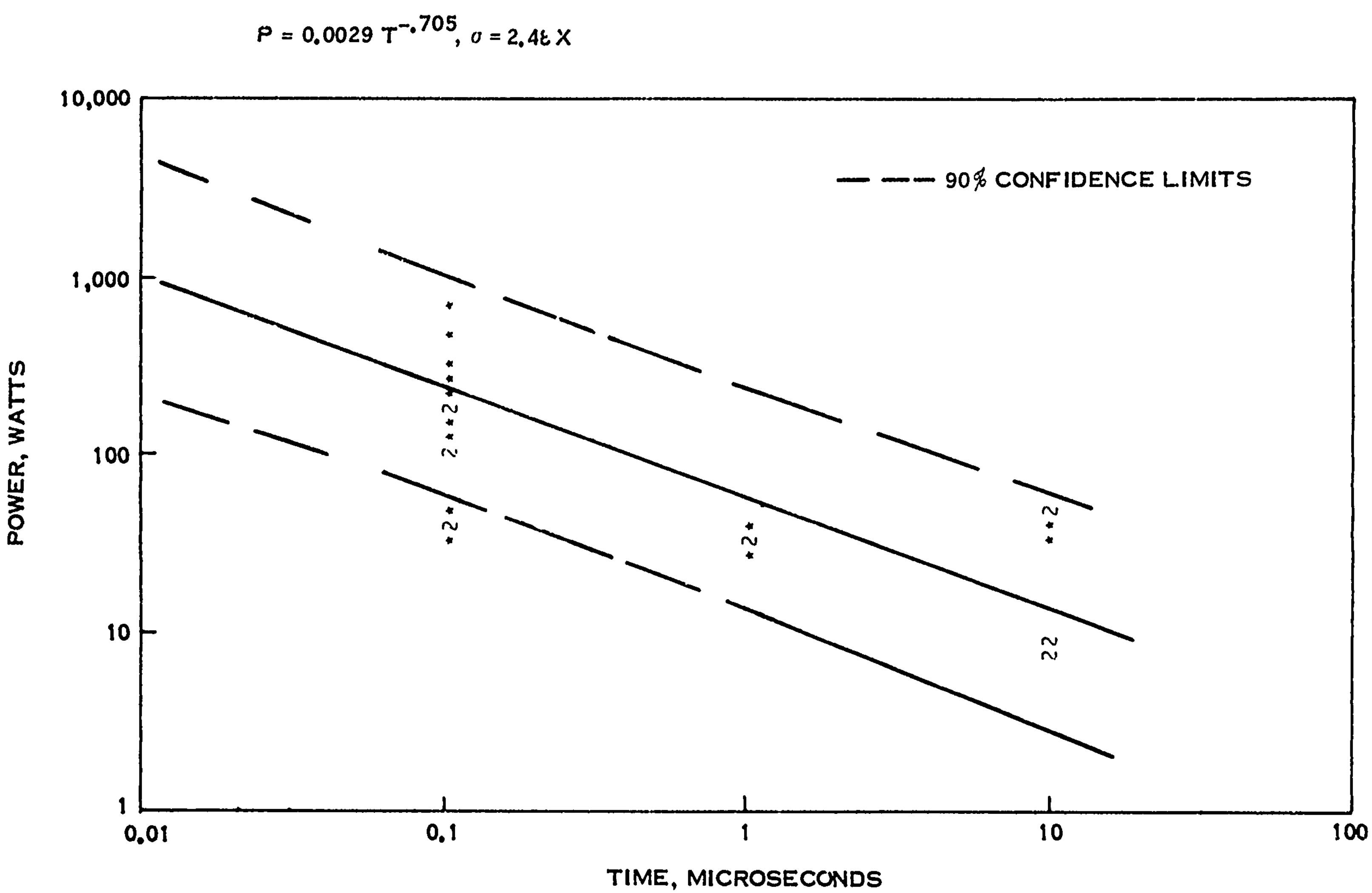

Figure 35. Output Power Failure Model of Schottky TTL Devices

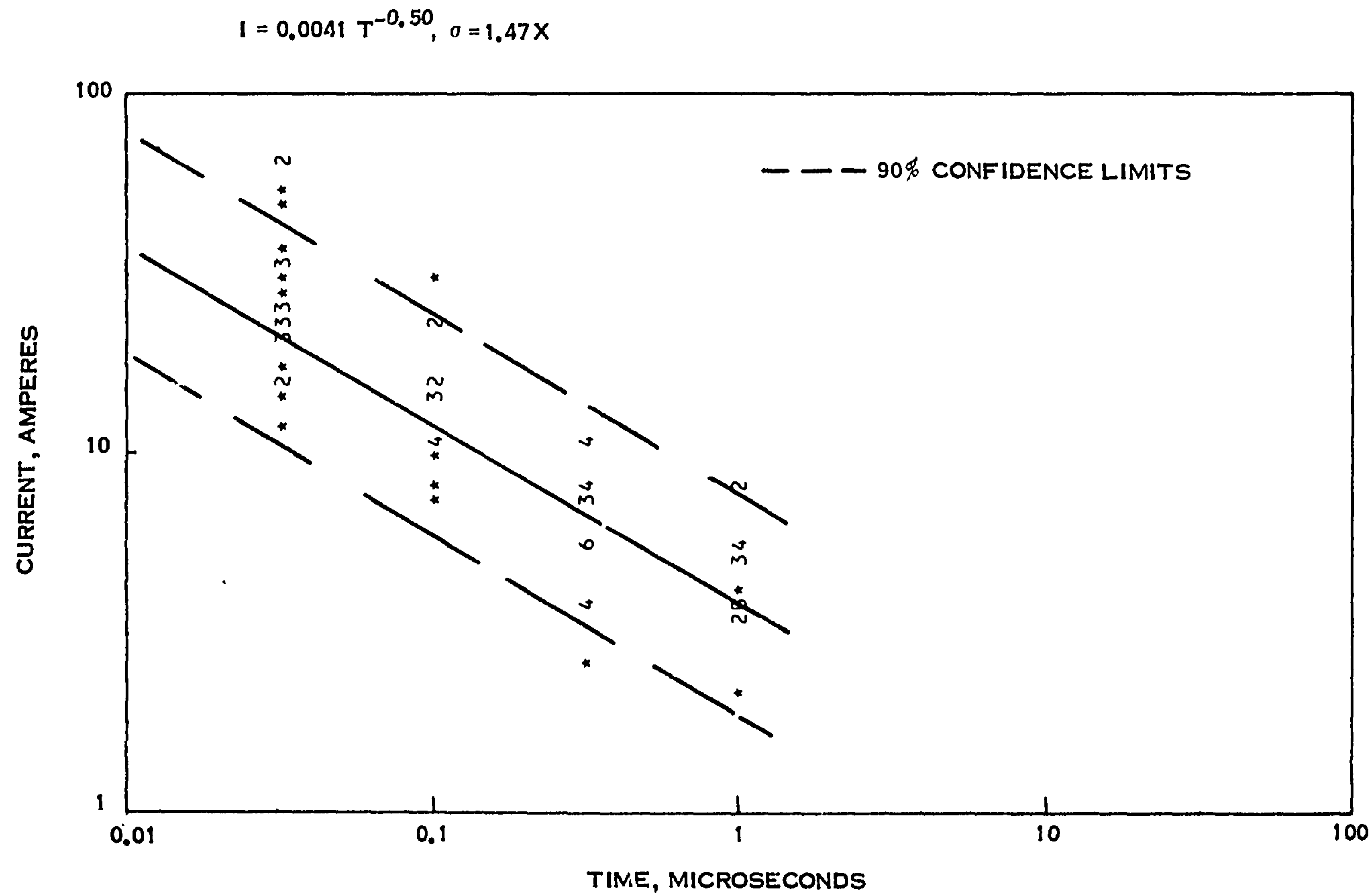

Figure 36. Input Current Failure Model of Low Power Schottky TTL Devices

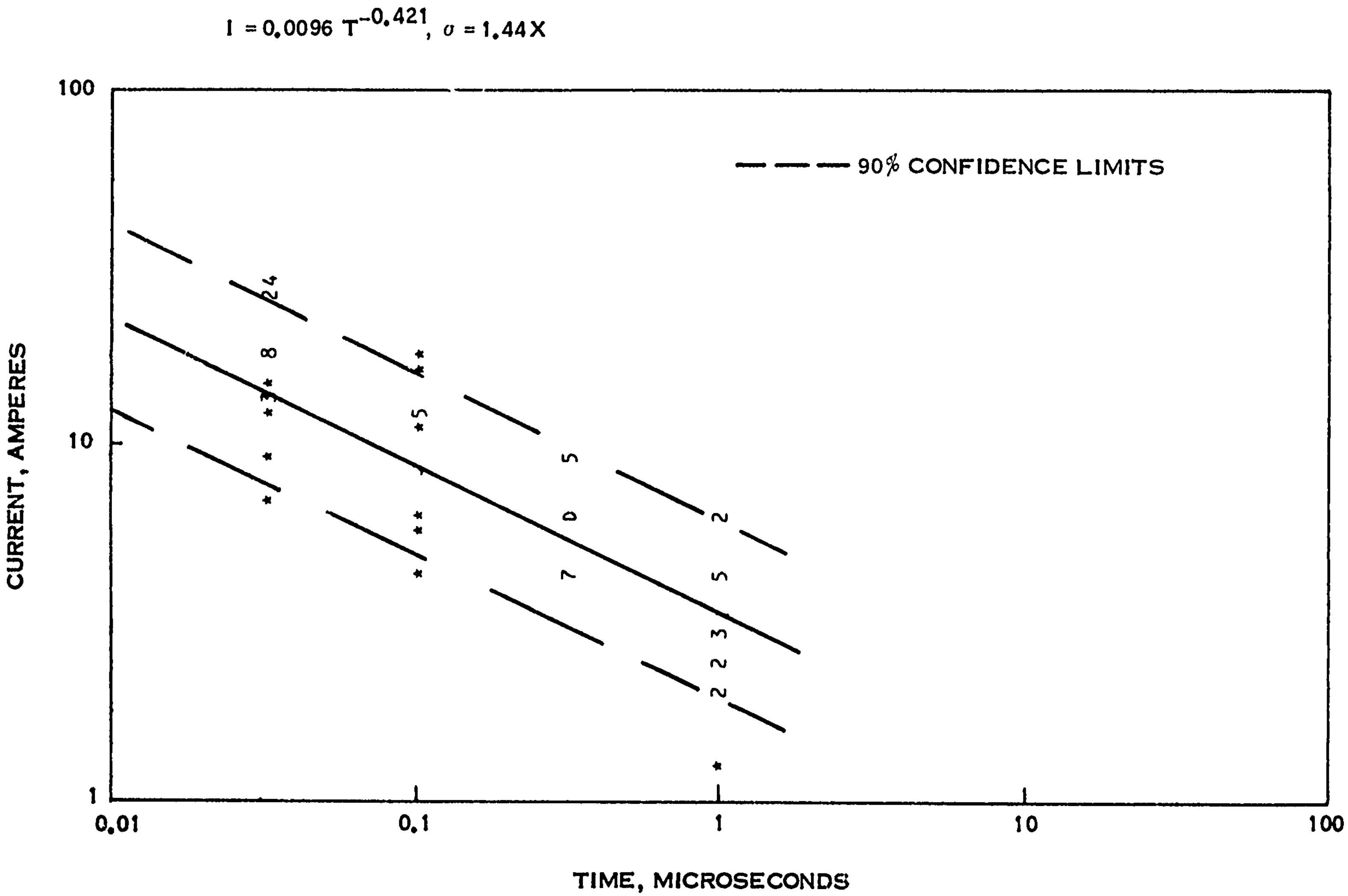

Figure 37. Output Current Failure Model for Low Power Schottky TTL Devices

$R_{avg} = 25.4\ I^{-0.522},\ \sigma = 2.0X$

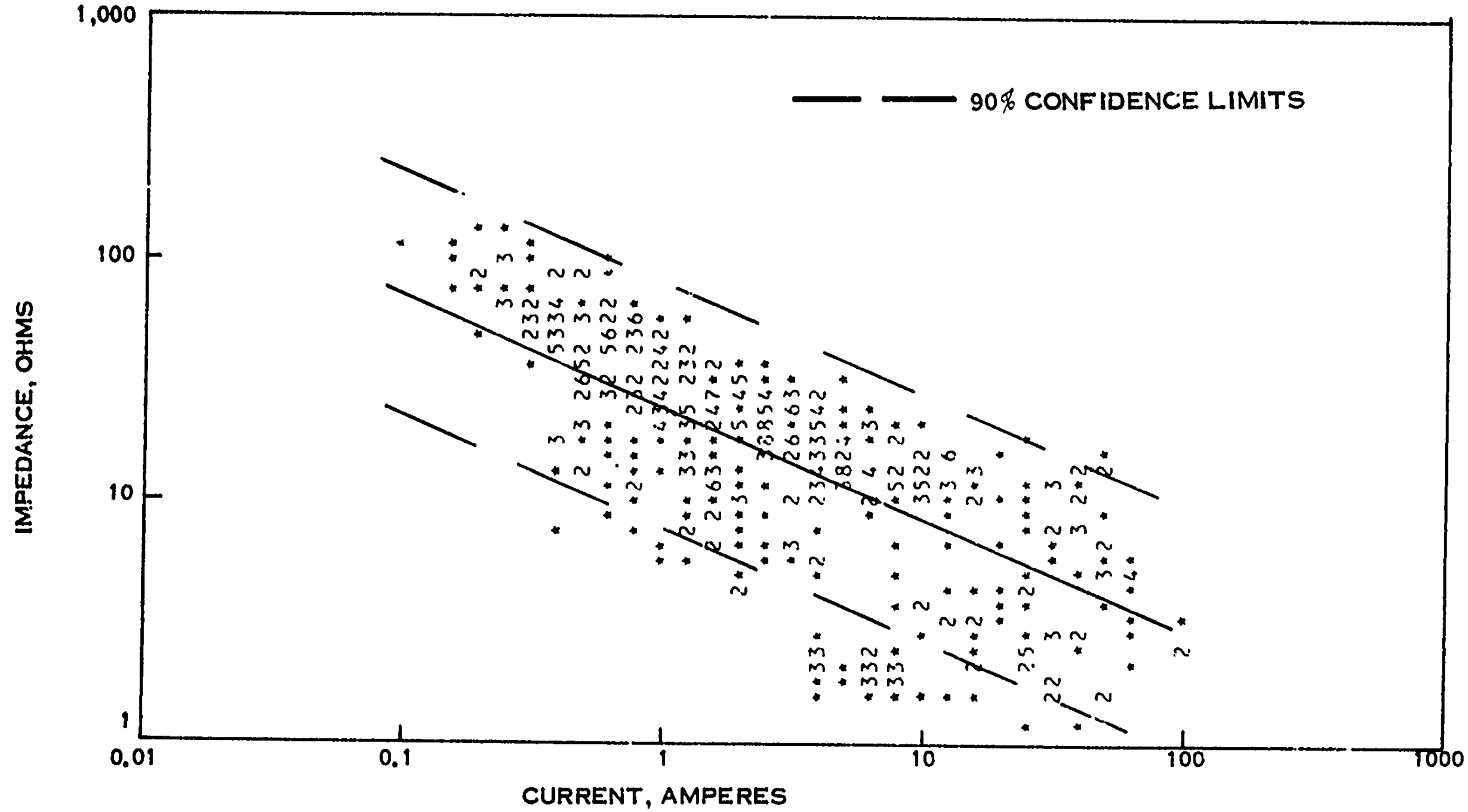

Figure 38. Impedance Model for all TTL Type Devices

$P = 0.274\, C^{1.83}\, t^{-1.00}$, $\sigma = 2.35$

NO POINTS = 122
NO PARTS = 7

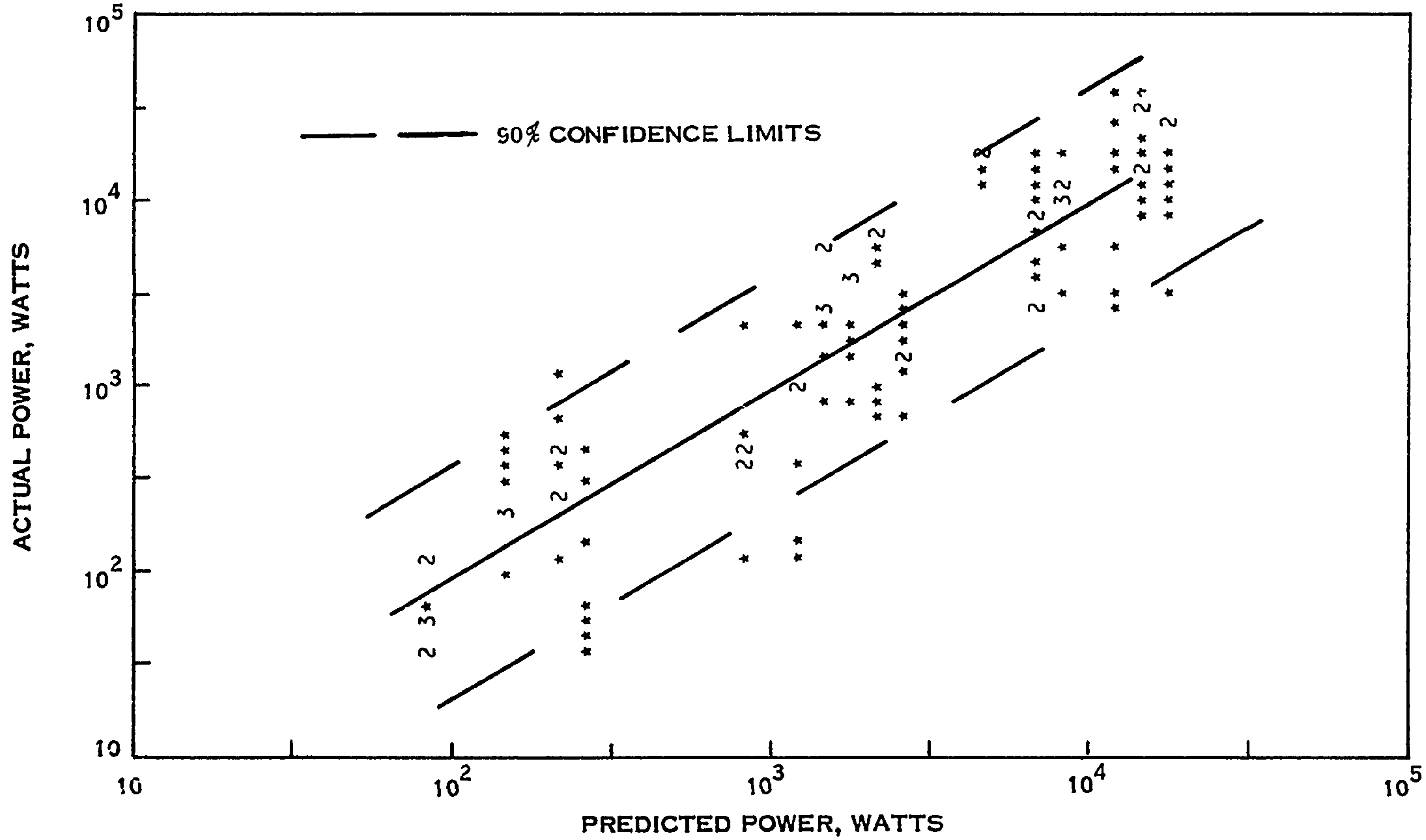

Table 18

Average Measured Capacitance of

Seven TTL Devices

DEVICE	CAPACITANCE, PF TERMINAL (TO GROUND)		
	INPUT	OUTPUT	POWER
SN74S00	13.5	12.5	44
SN74S112	16.5	18	108
SN74LS00	11	10.2	28
SN74LS112	15	16.5	80
SN74L00	8	8.5	50
SN74L04	10	9.5	85

factor of 3.8. This model for time and capacitance is shown in Figure 40.

5.2.5) EMITTER COUPLED LOGIC MODELS

Emitter coupled logic (ECL), a non-saturating type of logic and is the fastest logic family presently available. Data for these devices are obtained from one manufacturer and two sources (1) and (4). The data from (4) is only for the input terminal and interestingly show much lower power failure thresholds than the data from data source (1). This could be the result of manufacturing changes over time (the dates of these reports are about one year apart). This difference in the data is the major cause of the relatively large standard deviation (3.56X) of the input power failure model. The models that were generated for this class of devices are summarized in Table 19. The large difference in input power failure levels is shown in Figure 41. The other terminals, output and power supply, did not contain data from two sources and hence, did not have the large sigma that was exhibited by the input terminal. No valid models using the electrical parameters could be generated for this category of devices. This can be attributed to the small amount of data that exists for this category.

5.2.6) LINEAR MODELS

The linear devices category included such functional parts as operational amplifiers (op-amp), comparators, and voltage regulators. The models that have been generated for this overall category are tabulated on Table 20. The standard deviation (sigma) of these models was larger than the sigmas of the models for other categories. One reason for this is that unlike digital logic families, linear devices were not similar in terms of transistor sizes, construction, and manufacturing processes. The rather large spread in data of this category for the input current failure threshold versus time is shown in Figure 42. Figure 43 shows the characteristic dependence of impedance on the current level that was exhibited by most of the device categories. The standard deviation of the average impedance model was fairly low, 2.2X, while the power model's standard deviation is quite large, 4.8X. The linear category was further separated into two functional categories, op-amps and comparators. At a pulse width of one microsecond, the power failure thresholds of the op-amps were between a factor of 2.7 and 8.1 greater than the power failure thresholds of comparators. Although the spread in data was fairly large (sigmas 2.6X to 4.5X), the data for comparators showed this type of device to be consistantly more susceptible to damage than the op-amps devices. The higher susceptibility of comparators could be expected by studying the circuit configuration. The input of several of the comparators in the data base consists of a PNP transistor whose base is the

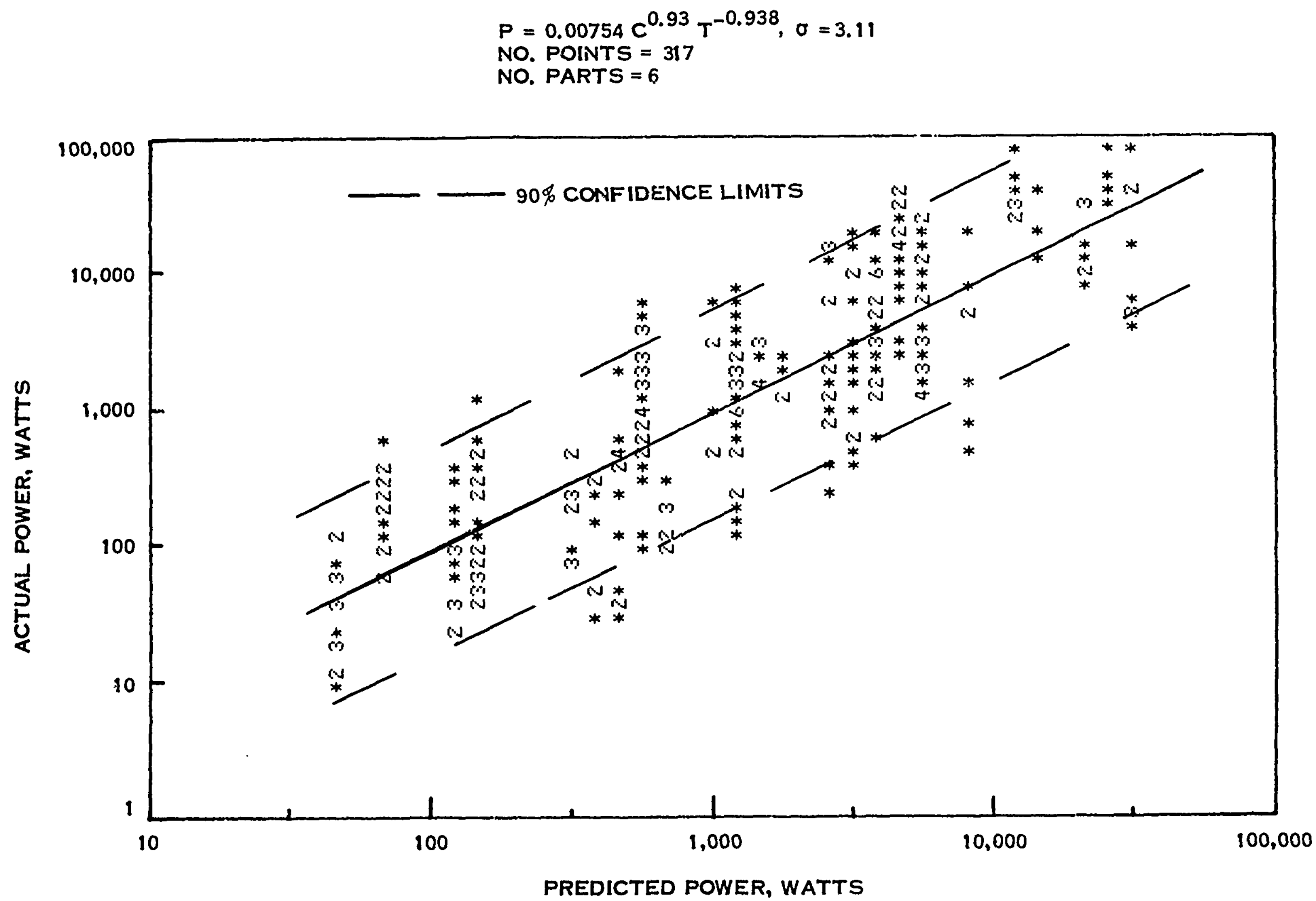

Figure 40. Power Failure Model of TTL Devices as a Function of Capacity and Time All Terminals Together

Table 19. Summary of ECL Models

Model	Input	σ	# Points	# Types	Output	σ	# Points	# Types	Power	σ	# Points	# Types
P_{avg}	$P = 0.13\ t^{-0.47}$	3.56X	62	6	$P = 0.29\ t^{-0.41}$	2.9X	39	4	$P = 0.09\ t^{-0.64}$	1.58X	33	4
I_{avg}	$I = 0.075\ t^{-0.266}$	2.22X	49	6	$I = 0.16\ t^{-0.21}$	2.03X	39	4	$I = 0.086\ t^{-0.31}$	1.48X	33	4
R_{avg}	$R = 31.7\ I^{-0.77}$	1.80X	49	6	$R = 15.6\ I^{-0.52}$	1.66X	39	4	$R = 43.3\ I^{-0.81}$	1.61X	33	4

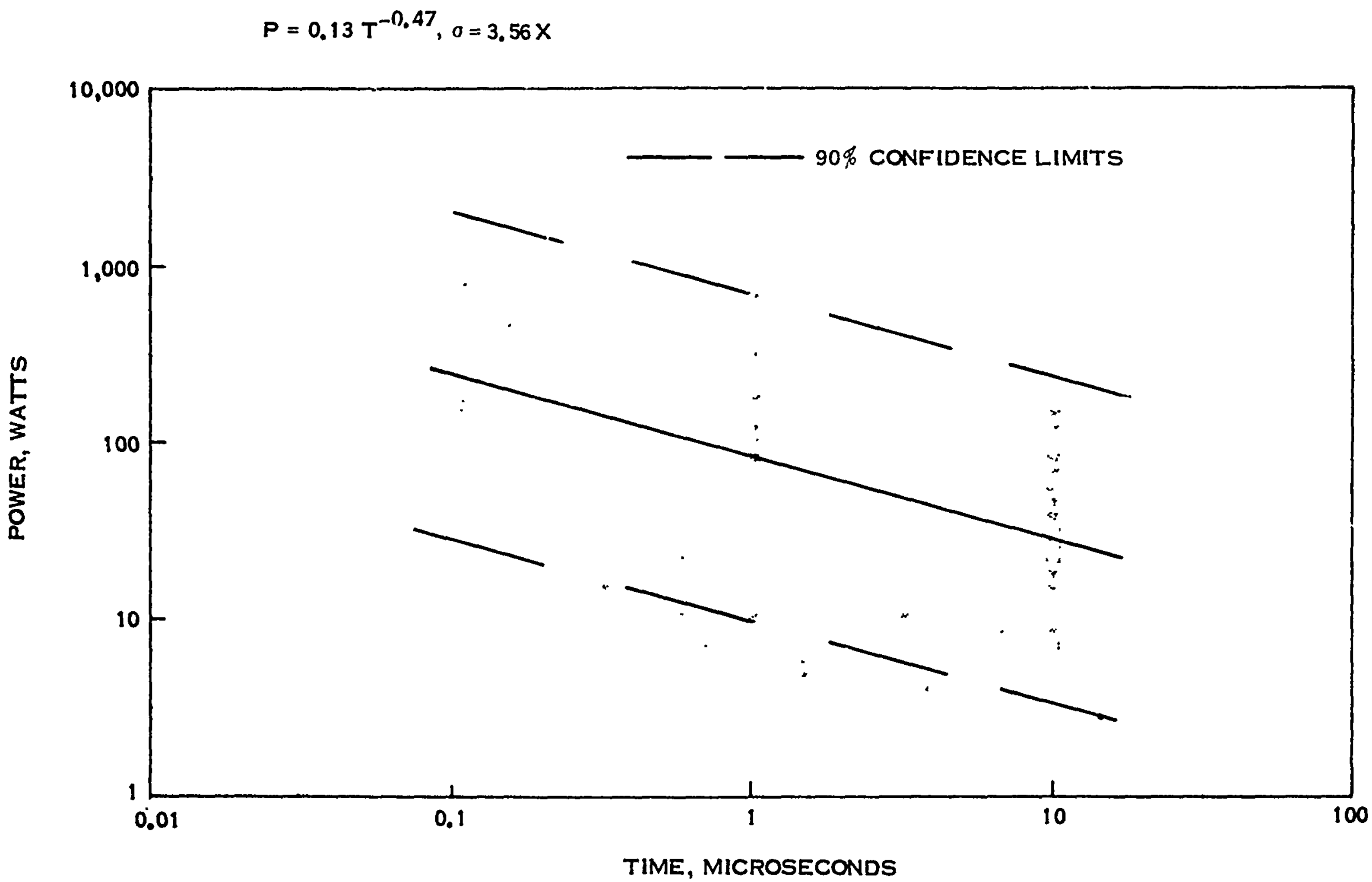

Figure 41. Input Power Failure Model for ECL Devices

Table 20. Summary of Linear Models

Model	Input	σ	# Points	# Types	Output	σ	# Points	# Types	Power	σ	# Points	# Types
All Linear												
P_{avg}	$P = 0.038\ t^{-0.57}$	4.8X	217	20	$P = 0.072\ t^{-0.59}$	3.3X	173	19	$P = 0.019\ t^{-0.65}$	3.4X	128	14
I_{avg}	$I = 0.03\ t^{-0.29}$	3.4X	217	20	$I = 0.078\ t^{-0.3}$	2.2X	167	18	$I = 0.046\ t^{-0.32}$	2.6X	126	13
R_{avg}	$R = 53.5\ t^{-0.66}$	2.2X	217	20	$R = 23.7\ t^{-0.46}$	2.3	167	18	$R = 30.9\ t^{-0.68}$	3.3X	126	13
OP-AMPS												
P_{avg}	$P = 0.2\ t^{-0.47}$	4.3X	144	13	$P = 0.044\ t^{-0.66}$	2.8X	112	13	$P = 0.63\ t^{-0.45}$	3.2X	61	9
I_{avg}	$I = 0.06\ t^{-0.25}$	3.4X	144	13	$I = 0.11\ t^{-0.30}$	2.2X	106	12	$I = 0.24\ t^{-0.22}$	2.44	59	7
Comparators												
P_{avg}	$P = 4 \times 10^{-6}\ t^{-1.1}$	4.5X	49	5	$P = 0.12\ t^{-0.52}$	4.3X	35	4	$P = 0.00085\ t^{-0.84}$	2.6X	27	3
I_{avg}	$I = 3.9 \times 10^{-5}\ t^{-0.68}$	3.0X	49	5	$I = 0.023\ t^{-0.35}$	2.1X	35	4	$I = 0.00033\ t^{-0.60}$	2.6X	27	3

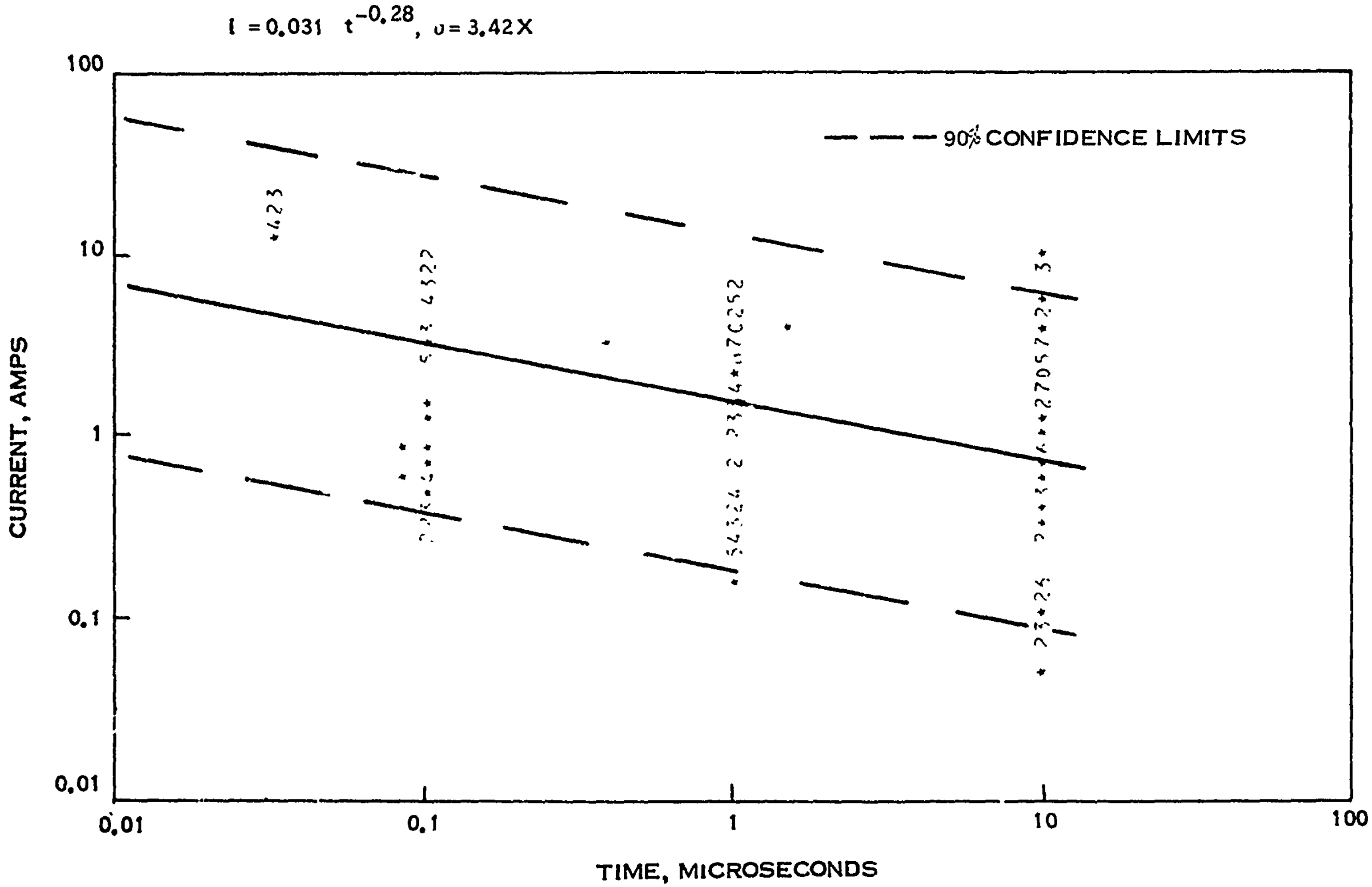

Figure 42. Input Current Failure Model for Linear Devices

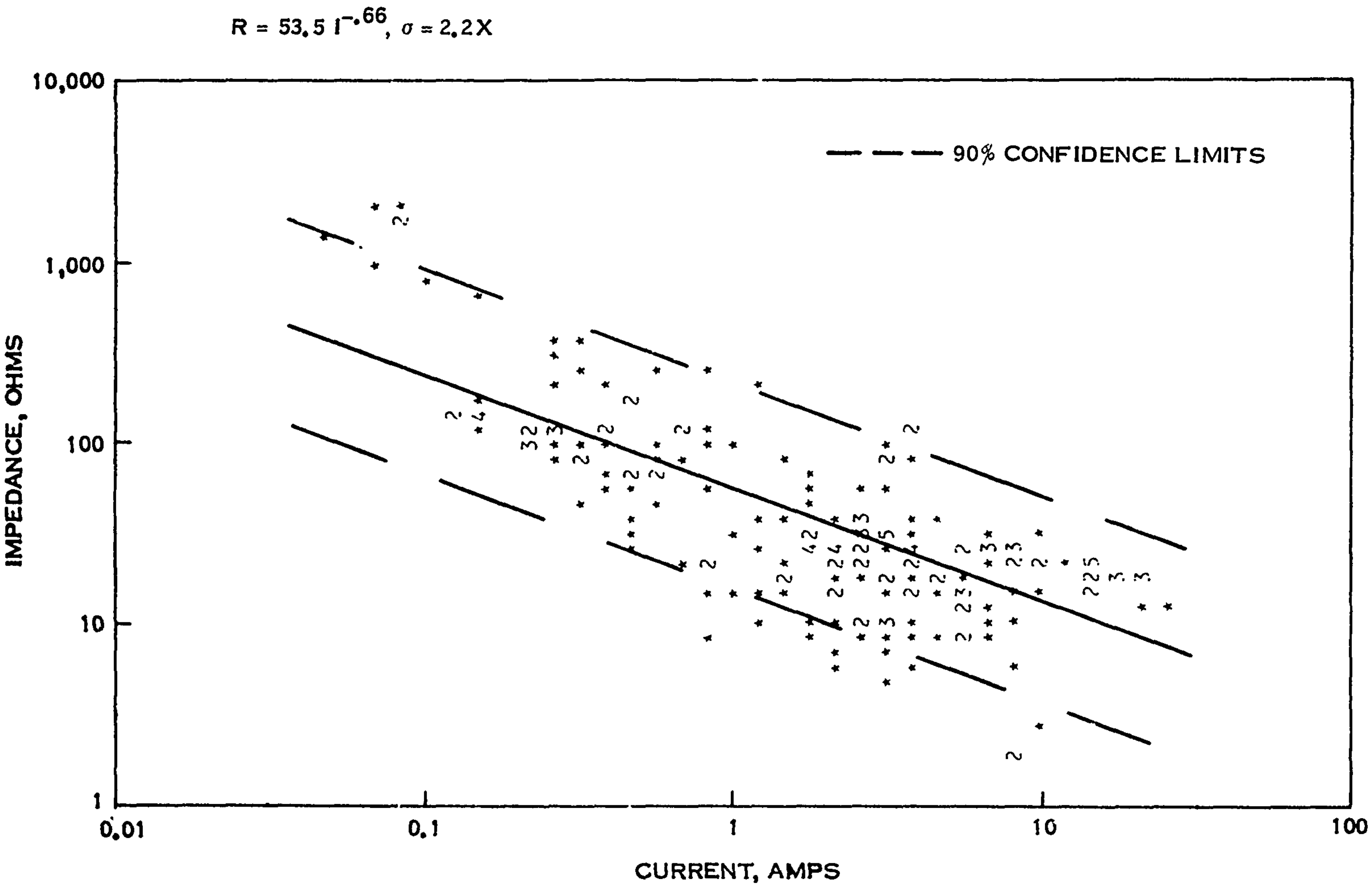

Figure 43. Input Impedance Model of Linear Devices

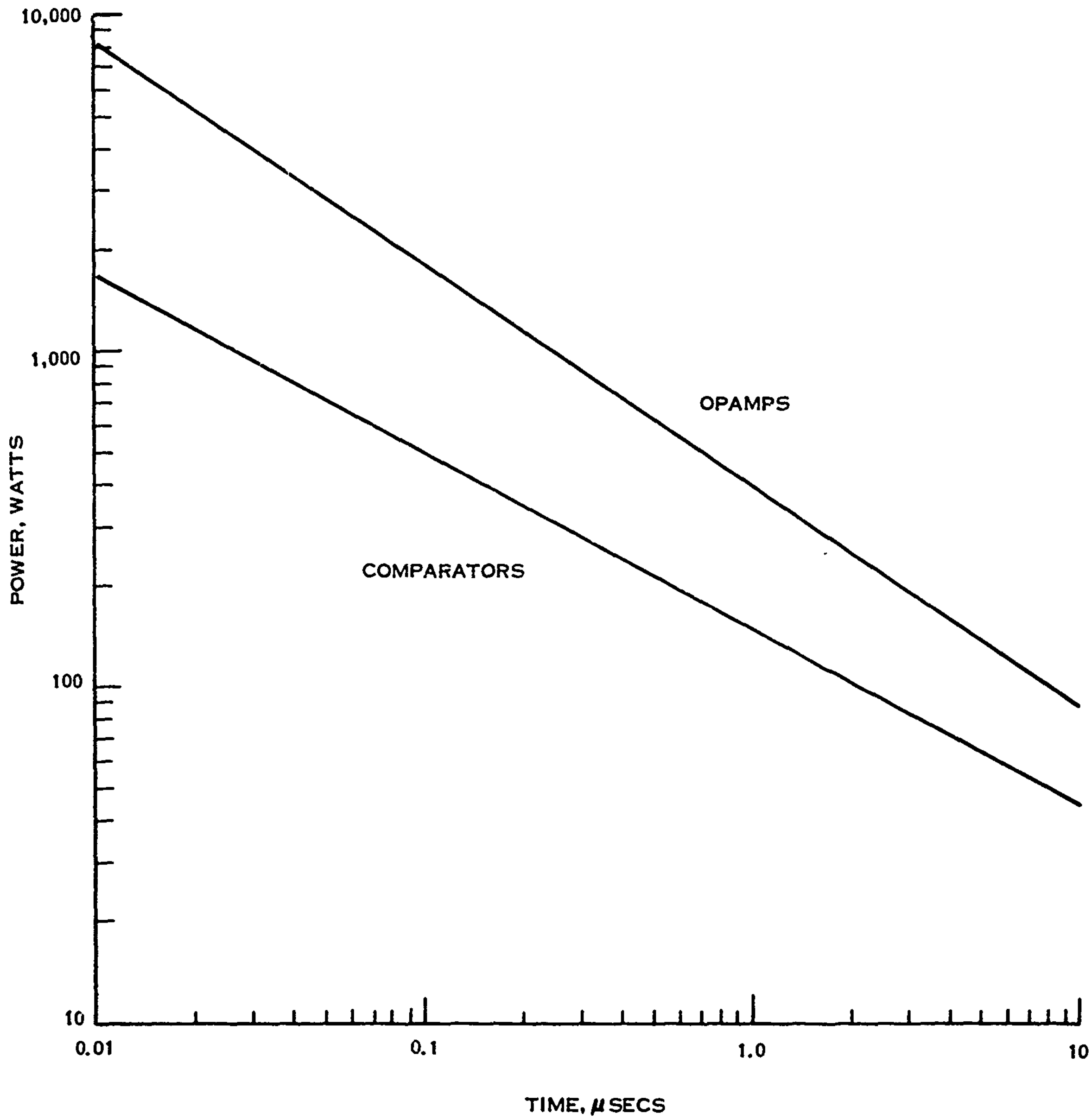

Figure 44. Comparison of the Output Power Failure Threshold of OP-AMPS and Comparators

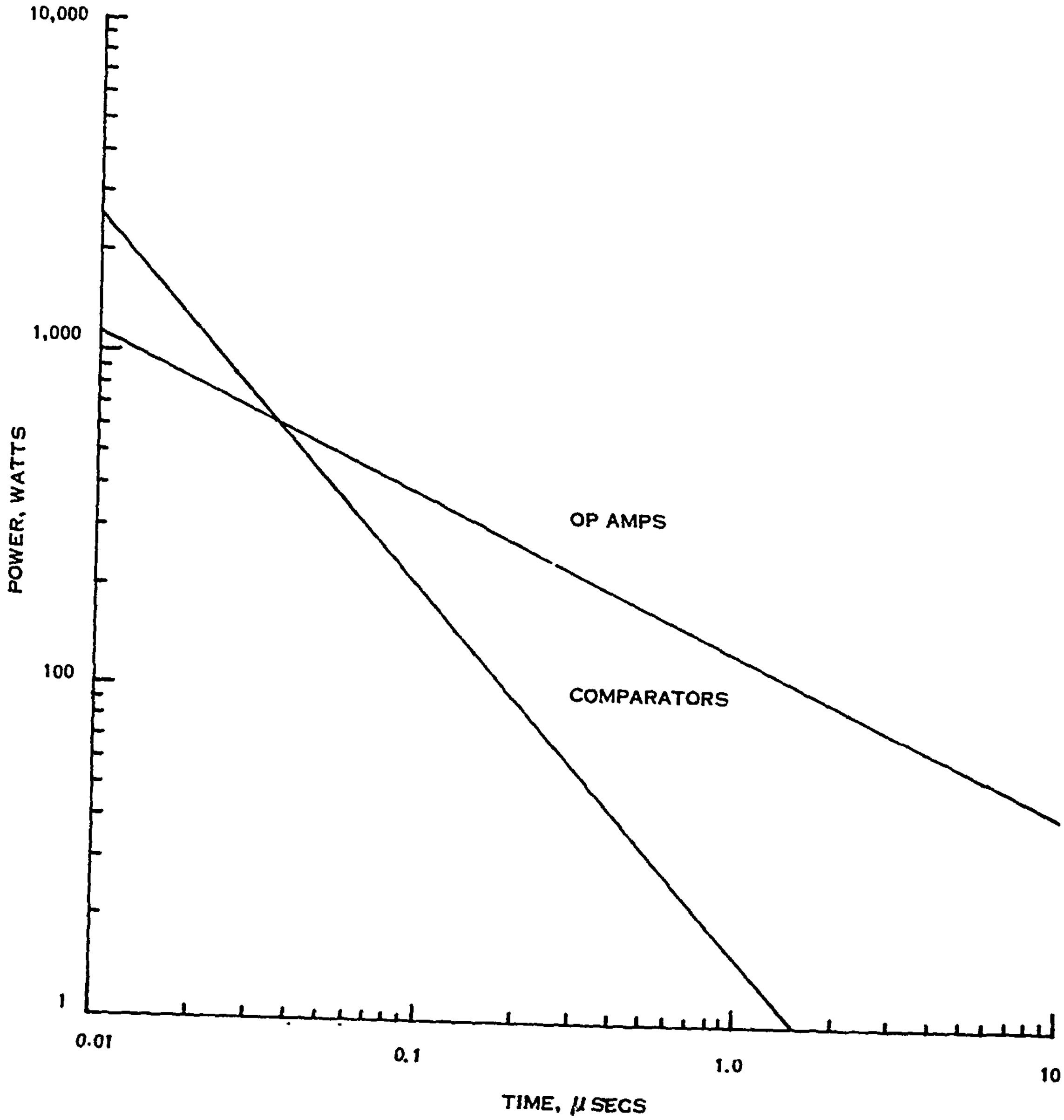

Figure 45. Comparison of the Input Power Failure Thresholds of OP-AMPS and Comparators

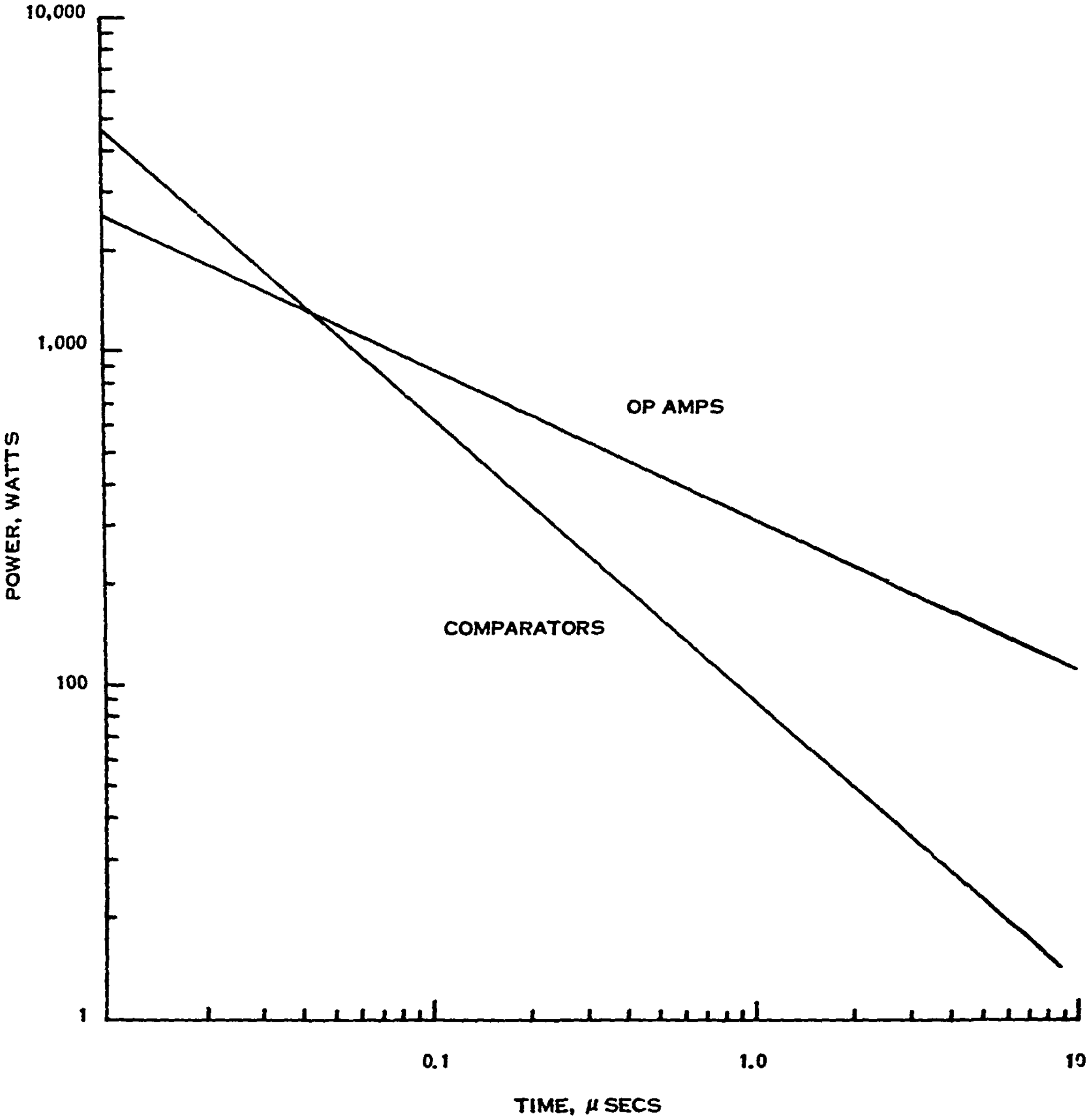

Figure 46. Comparison of the Power Supply Power Failure Threshold of OP-AMPS and Comparators

input and the collector is tied directly to ground. Consequently, this single junction could absorb almost all of the energy when this type of device is pulsed from input to ground. Most opamps have a much different type of structure. Opamps utilize a transistor with it's base as an input, it's emitter is current regulated and the collector to a load. As a result of this type of input, energy will be dissipated in several elements rather than just one junction, which should result in a device less susceptible to damage. The output stage of a comparator is a digital output rather than to an operational amplifier similar to output. This often consists of an open collector output transistor rather than the push-pull type output that many opamps employ.

Op amps showed a fair correlation between measured breakdown voltage of the output terminal and the power failure threshold (Fig. 44-46). The correlation between the input and power supply terminals and the breakdown voltages was minimal. A model of the output power failure threshold versus time and breakdown voltage is shown in Fig. 47, 48. The sigma of this model was about 12 percent lower than nominal power failure threshold versus time model. This was the only electrical parameter that showed any significant correlation to the output power failure threshold. The power supply terminal's power failure level correlated with the thermal resistance. Other terminals of linear devices do not show any significant correlation with this parameter. The sigma of the power supply terminal power failure model versus time and thermal reswastance is about ten percent improved over the nominal model. The input terminal power failure threshold showed a good correlation to the measured values of capacitance as shown in Figure 49 and to some extent (5% reduction in sigma) to the breakdown voltage. The capacitance which was a good predictor for all terminals for the TTL devices was not good for all terminals of the linear devices. Table 21 shows the average of the measured values of capacitance for the four linear devices that were tested. The measured values were generally very close in value. One reason why the capacitance was not a predictor for the linear devices was that of the four devices tested on this program, two were op-amps and two were comparators. Since these two functional classes exhibited different pulse power characterwastics, it is probably not fair to lump them together to determine the correlation with the measured capacitance. It is recommended that further effort be put into obtaining more data so that this correlation could be assessed. The resulting models as a function of the devices electrical parameters are shown in Table 22.

$P \quad 0.011\, V_B^{0.72} \tau^{-0.77}, \sigma = 1.83$

NO POINTS = 55
NO PARTS = 8

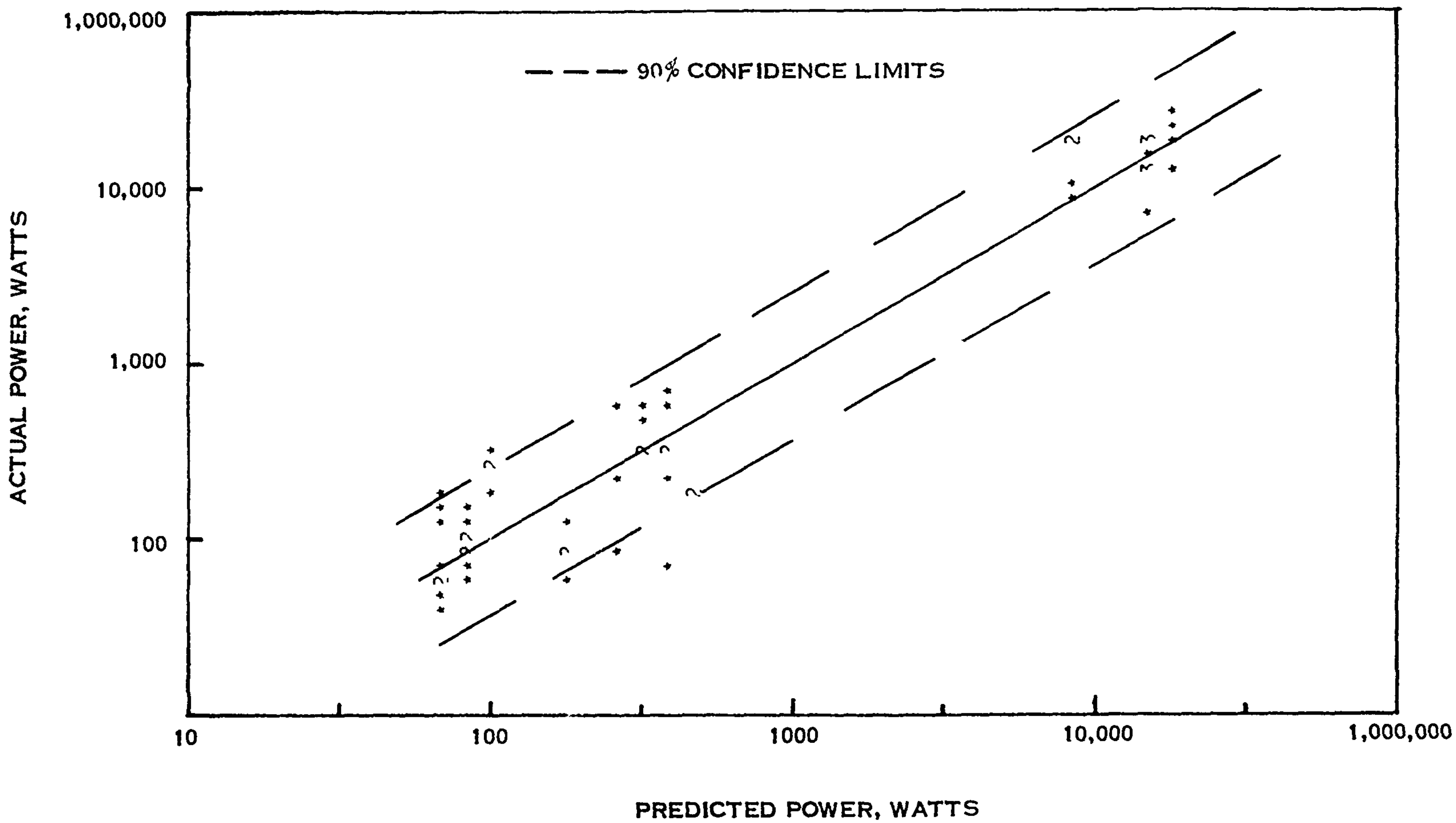

Figure 47. OP-AMP Output Power Failure Model

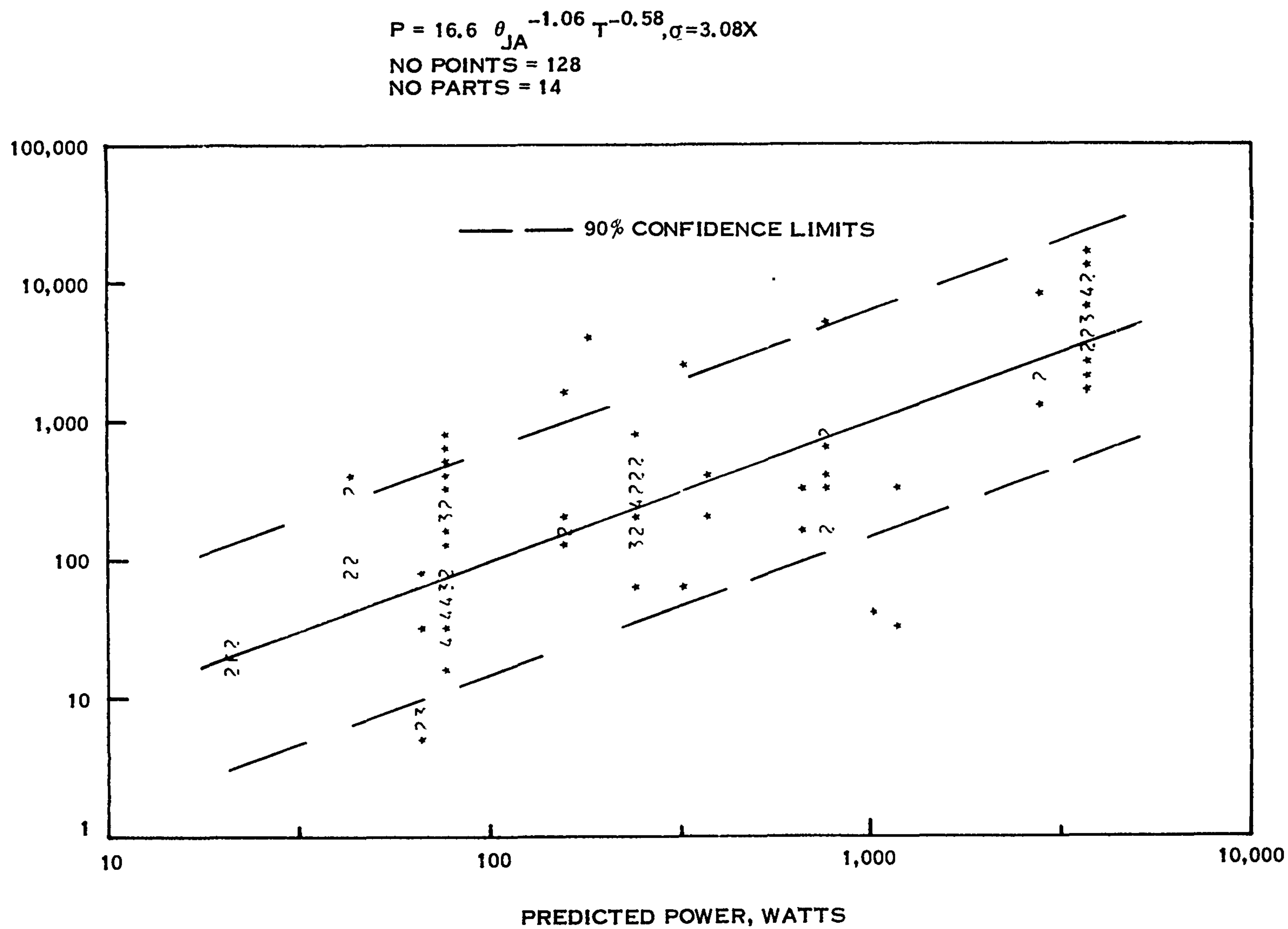

Figure 48. Power Supply Power Failure Model

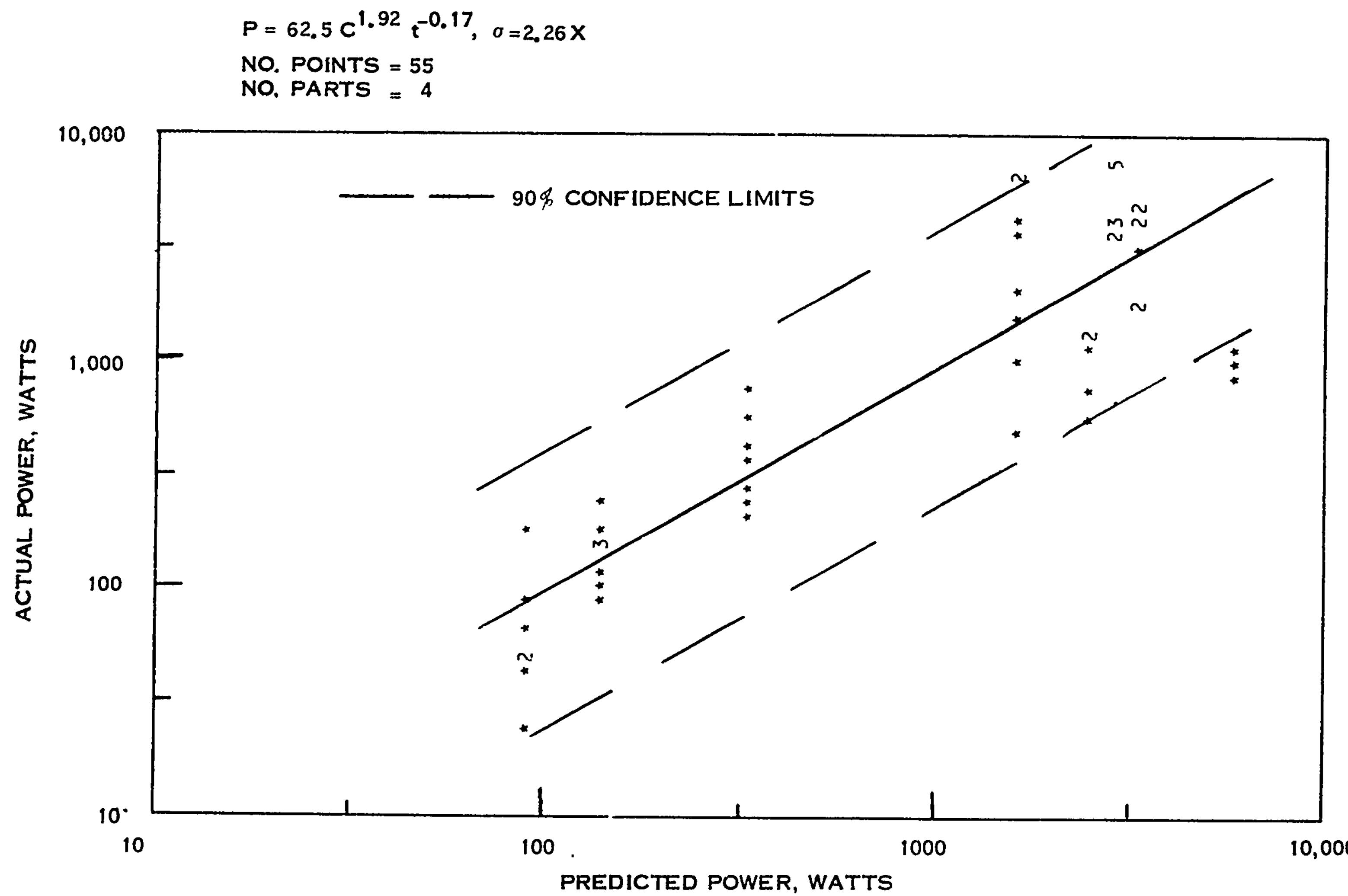

Figure 49. Linear Input Power Failure Model

Table 21

Average Measured Capacitance of

Four Linear Devices

DEVICE	CAPACITANCE, PF		
	INPUT	OUTPUT	POWER
LM301A	7.5	30.5	25
LM308	9	18	42
LM339	12	14.3	17
LM311	6	25	19

Table 22

Summary of Linear Models As A

Function of Electrical Parameters

CLASS. CATEGORY	TERMINAL	MODEL	SIGMA	NO. POINTS	NO PARTS
OPAMP	OUTPUT	$P = 0.011\ V_B^{0.72} t^{-0.77}$	1.83X	55	8
LINEAR	POWER SUPPLY	$P = 16.6\ \theta_{JA}^{-1.06}\ t^{-0.58}$	3.08X	128	14
LINEAR	INPUT	$P = 62.5\ C^{1.92} t^{-0.71}$	2.26X	55	4
LINEAR	INPUT	$P = 40 V_B^{0.13} C^{1.85}\ t^{-0.70}$	2.16	55	4

Where

P = POWER IN WATTS

V_B = BREAKDOWN VOLTAGE IN VOLTS

t = PULSE WIDTH IN SECONDS

C = TERMINAL CAPACITANCE IN pf

θ_{JA} = THERMAL RESISTANCE, JUNCTION TO AMBIENT IN $^{\circ}$C/W

5.2.7) MODEL USEAGE

This program developed engineering type damage models to predict both surge impedances and failure thresholds of integrated circuits when exposed to EMP type environments. These models based on theoretical considerations and empirical data, determine the power or current as a function of pulse width for device categories which were based on the device family (TTL, RTL, DTL, etc.) and the terminal of interest (input, output, or power supply). These categories have been defined as shown in Tables . The models have the following forms.

$$P=At^{-B}$$

$$I=Ct^{-D}$$

$$R=EI^{-F}$$

where P = power in watts
I = current in amps
t = pulse width in seconds
R = impedance in ohms
A,B,C, & D = experimentally determined constants

The pulse widths for which the data on which the models are based, are generally from 10 nanoseconds to 10 microseconds for linear and TTL categories and from 100 nanoseconds to 10 microseconds for the RTL, DTL, and ECL categories. The model is simply a resistor whose value is a function of current.(Ravg=EI) The allowable stress (power or current) is defined as a function of time ($I = Ct^{-D}$).

The general method of analysis is as follows:

(1) compute failure current, I, at t

$$I=Ct^{-D}$$

(2) compute the impedance at I

$$R=EI^{-F}$$

(3) solve for V

$$V=IR$$

6) CONCLUSIONS

The present program has shown that engineering type models can be developed to predict both the surge impedance and failure levels of small scale junction integrated circuits when exposed to EMP environments.

A comprehensive literature search of numerous DOD and NASA agencies and contractors was utilized in order to uncover and obtain existing experimental pulse response and damage data for different integrated circuit part types. The modeling effort was based on the extensive data base obtained from the literature search and on the data from the tests that were performed during the present program. The experimental results of this program extended the data base for TTL and linear devices to 10 nanoseconds pulse widths. Selective testing was also performed on devices which were incompletely characterized in the data base obtained from the literature search. An extensive amount of pulse power response data for low power Schottky devices was obtained for the first time.

This effort generated models for the power failure threshold as a function of pulse width, the current failure threshold as a function of pulse width and the impedance as a function of current. The pulse current failure models and the current dependent impedance models that were developed represent the first such extensive formulations for integrated circuits. These models were generated for each significant category of integrated circuits for which data were available. The categories the were established included the following:

RTL Devices
DTL Devices
TTL Devices
Standard TTL Devices
Low Power TTL Devices
High Speed TTL Devices
Schottky TTL Devices
Low Power Schottky TTL Devices
Linear Devices
Operational Amplifiers (op-amps)
Comparators

The standard deviation of each model is given so that predictions of the failure level of an untested device can be made with any desired degree of confidence. In addition, the graphs are plotted with associated 90% confidence limits.

The correlations between the electrical parameters of a device and its surge impedance and power failure threshold were also examined. The results of this examination showed terminal capacitance to be the parameter that exhibited the

most correlation with the device failure threshold. Other electrical parameters showed some correlation with the power failure threshold, however, these results were not systematic in that the other electrical parameters did not show good correlation across different categories. Thus, categorization of the integrated circuits resulted in better models than grouping all devices together and attempting to correlate their failure threshold with any combination of electrical parameters.

7) RECOMMENDATIONS

The key element in this modeling is to categorize the integrated circuits by their device family and functional classification. Current and power failure models as well as a surge impedance model as a function of current were developed for several categories of integrated circuits.

In view of the results shown herein, it is recommended that the modelling effort be extended to cover other device categories such as voltage regulators, analog switches, digital memories, buffers, analog to digital converters, digital to analog converters, line drivers and line receivers. In addition, models for MOS and CMOS devices are needed. Additional experimental work is also recommended for ECL devices. For this category little data is available. For the most recent generation, ECL 10000, there is no data at all. For most of the categories defined herein, there was a sufficient variation in terms of manufacturer. However, this was not the case for several of the TTL series models. Since these categories represent the currently most popular bipolar family, it is recommended that the effects of different manufacturers on the TTL series (low power and low power Schottky) models be assessed.

Electrical parameter regression analyses were also performed. This study showed the terminal capacitance to be the most significant predictor of all of the electrical parameters that were considered. In fact, terminal capacitance was a good predictor of the terminal failure threshold when all terminals of several different integrated circuits were grouped together. This type of modeling using the terminal capacitance of the device should be extended to other device categories, especially the linear category.

Dielectrically isolated devices appeared to be more vulnerable than junction isolated devices based on data for DTL and linear devices, however, sufficient data for the three terminals of interest (input, output and power supply) were not available so that strong conclusions could not be drawn. Additional experimental work is recommended for dielectrically isolated devices. Some dielectrically isolated TTL devices should be tested.

It is also recommended that this modeling effort be extended to MSI (medium scale integration) and LSI (large scale integration) integrated circuits as these complex devices are becoming more and more a vital part of modern electronic systems. It might be feasable to extend the small scale IC models to the larger scale IC's since the input and outputs are similar. In order to determine if this is feasable it would be necessary to determine where damage occurs in multiple series junctions. That is, as the damage confined to the devices at the terminal interface or can the damage

occur past the interface? If the damage, was only at the terminal interface that it would be possible to use the present small scale IC models to predict MSI and LSI performance. Lastly, it is recommended that synergistic effects be investigated to determine if the presence of ionizing radiation changes the susceptibility of integrated circuits to EMP type environments. It is quite possible that a situation may be encountered where an IC may be more susceptible to damage in the synergistic case because a less susceptible device at the device terminal ionizes allowing the EMP current to pass on to a more susceptible junction farther into the integrated circuit. Since the combined effects are present in reality, it is important to consider their interaction in the design of hardened electronic systems.

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APPENDIX A.--INTEGRATED CIRCUIT PULSE DATA

The detailed pulse damage data for each integrated circuit type obtained during this program is tabulated in this appendix. The headings on the Tables are as follows.

Device	Part Type
MFG	Manufacturer
Time	Pulse Width
Pin	1 = input-ground 2 = output-ground 3 = power supply-ground other numbers refer to other configurations polarity is designated by $\pm$
Pwr	Average Power
V_{avg}	Average Voltage
I_{avg}	Average Current
SOD	Source of Data (Shown in Table 8)

The order of devices on this table is RTL, DTL, TTL, ECL then linear. The actual device order is shown on the following page.

APPENDIX A

RTL Devices	DTL Devices	TTL Devices	ECL Devices	Linear Devices
908HC	930HC	MC4043	MC308G	LM105
909HC	930RC	7400DC	MC317F	709HC
910HC	932HC	MC7400L	MC304G	UA715
911HC	933HC	SN7490	MC1678L	UA740
912HC	DM933	SN74163	MC351G	UA776
	944HC	MC4006	MC301C	MC1530G
	DM944	SN7400		LM103.1 (1.8V)
	945HC	SN7402		LM1035. (5.6V)
	DM945	SN7413		LM111H
	946HC	N7400F		LM302
	DM946	SN74H60		UA741
	DM948	SN74H00		UA747
	MC1488	SN74H05		N5710T
	MC1489	SN74L00		SN75107
	SE156	SN74L71		710
	SE180J	SN74L73		UA709
	MC930	SN74L95		MC1530G
	RD210	SN74S00		709R
	MC933F	9046		SN72709
	1053	6041		1752
	993	SN7491A		RA239
	I3101	SN7472N		
	F4501	SN74H05		
	RD220	54L00		
	RD211	54L04		
	RD211B	54L10		
	RD221	F9344		
	F9930	SN5420		
	TI946	DRA2001		
	SE8481	SN74L00		
	SG140	SN5404		
	RD210	54L00		
		54L122		

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
908HC	FSC	10.00	-1	123.	67.2	1.8	1
908HC	FSC	10.00	-1	110.	58.1	2.0	1
908HC	FSC	10.00	-1	63.	54.0	1.3	1
908HC	FSC	10.00	-1	110.	58.0	1.9	1
908HC	FSC	1.00	-1	118.	74.0	1.6	1
908HC	FSC	1.00	-1	106.	65.4	2.2	1
908HC	FSC	1.00	-1	140.	80.0	1.8	1
908HC	FSC	1.00	-1	106.	76.7	2.0	1
908HC	FSC	1.00	1	608.	135.0	4.5	1
908HC	FSC	1.00	1	719.	132.0	5.5	1
908HC	FSC	1.00	1	555.	108.6	5.1	1
908HC	FSC	1.00	1	668.	125.9	5.3	1
908HC	FSC	10.00	-2	16.	13.4	1.2	1
908HC	FSC	10.00	-2	16.	11.6	1.4	1
908HC	FSC	10.00	-2	13.	12.3	1.1	1
908HC	FSC	10.00	-2	13.	10.0	1.3	1
908HC	FSC	10.00	2	34.	36.3	1.0	1
908HC	FSC	10.00	2	13.	10.1	0.5	1
908HC	FSC	10.00	2	30.	30.3	1.0	1
908HC	FSC	10.00	2	36.	30.0	1.2	1
908HC	FSC	1.00	-2	69.	21.0	3.3	1
908HC	FSC	1.00	-2	77.	22.0	3.5	1
908HC	FSC	1.00	-2	86.	24.0	3.6	1
908HC	FSC	1.00	-2	95.	25.0	3.8	1
908HC	FSC	0.10	-2	224.	35.0	6.4	1
908HC	FSC	0.10	-2	268.	40.0	6.7	1
908HC	FSC	0.10	-2	179.	28.0	6.4	1
908HC	FSC	0.10	-2	211.	32.0	6.6	1
908HC	FSC	10.00	-3	193.	76.3	2.5	1
908HC	FSC	10.00	-3	184.	66.5	2.9	1
908HC	FSC	10.00	-3	182.	70.0	2.6	1
908HC	FSC	10.00	-3	174.	63.0	2.8	1
908HC	FSC	10.00	3	33.	82.0	0.4	1
908HC	FSC	10.00	3	44.	39.9	1.6	1
908HC	FSC	10.00	3	65.	87.0	0.8	1
908HC	FSC	10.00	3	71.	70.5	1.2	1
908HC	FSC	1.00	3	193.	110.5	1.8	1
908HC	FSC	1.00	3	177.	68.4	2.8	1
908HC	FSC	1.00	3	216.	90.0	2.4	1
908HC	FSC	1.00	3	195.	56.0	3.5	1
908HC	FSC	0.10	3	403.	115.0	3.5	1
908HC	FSC	0.10	3	500.	119.0	4.2	1
908HC	FSC	0.10	3	483.	105.0	4.6	1
908HC	FSC	0.10	3	510.	100.0	5.1	1
908HC	FSC	0.10	-1	288.	120.0	2.4	1
908HC	FSC	0.10	-1	375.	125.0	3.0	1
908HC	FSC	0.10	-1	307.	128.0	2.4	1
908HC	FSC	0.10	-1	285.	114.0	2.5	1
909HC	FSC	10.00	-1	21.	75.5	0.3	1
909HC	FSC	10.00	-1	37.	26.2	1.6	1
909HC	FSC	10.00	-1	37.	39.0	1.0	1
909HC	FSC	10.00	-1	43.	36.6	1.2	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
909HC	FSC	10.00	1	32.	72.0	0.4	1
909HC	FSC	10.00	1	32.	27.8	1.7	1
909HC	FSC	10.00	1	32.	93.0	0.3	1
909HC	FSC	10.00	1	41.	87.5	0.6	1
909HC	FSC	1.00	1	90.	108.5	0.9	1
909HC	FSC	1.00	1	91.	38.2	2.9	1
909HC	FSC	1.00	1	80.	27.5	3.0	1
909HC	FSC	1.00	1	94.	29.0	3.3	1
909HC	FSC	0.10	1	300.	120.0	2.5	1
909HC	FSC	0.10	1	240.	60.0	4.0	1
909HC	FSC	0.10	1	238.	108.0	2.2	1
909HC	FSC	0.10	1	228.	60.0	3.8	1
909HC	FSC	10.00	-2	16.	11.7	1.3	1
909HC	FSC	10.00	-2	20.	13.5	1.5	1
909HC	FSC	10.00	-2	15.	13.0	1.2	1
909HC	FSC	10.00	-2	18.	13.1	1.3	1
909HC	FSC	10.00	2	32.	26.3	1.2	1
909HC	FSC	10.00	2	34.	26.0	1.3	1
909HC	FSC	10.00	2	40.	33.5	1.2	1
909HC	FSC	10.00	2	44.	31.6	1.4	1
909HC	FSC	1.00	-2	41.	16.5	2.5	1
909HC	FSC	1.00	-2	53.	18.8	2.8	1
909HC	FSC	1.00	-2	33.	15.0	2.2	1
909HC	FSC	1.00	-2	38.	16.0	2.4	1
909HC	FSC	0.10	-2	280.	40.0	7.0	1
909HC	FSC	0.10	-2	263.	35.0	7.5	1
909HC	FSC	10.00	-3	71.	42.3	1.7	1
909HC	FSC	10.00	-3	61.	30.3	2.1	1
909HC	FSC	10.00	-3	71.	46.5	1.5	1
909HC	FSC	10.00	-3	67.	37.8	1.8	1
909HC	FSC	10.00	3	77.	60.5	1.3	1
909HC	FSC	10.00	3	59.	41.3	1.6	1
909HC	FSC	10.00	3	43.	78.5	0.6	1
909HC	FSC	10.00	3	61.	62.6	1.1	1
909HC	FSC	1.00	3	236.	122.5	2.0	1
909HC	FSC	1.00	3	213.	76.5	2.9	1
909HC	FSC	1.00	3	319.	107.4	3.0	1
909HC	FSC	1.00	3	321.	97.7	3.3	1
909HC	FSC	1.00	-3	276.	70.1	4.0	1
909HC	FSC	1.00	-3	270.	62.5	4.5	1
909HC	FSC	1.00	-3	285.	80.7	3.6	1
909HC	FSC	1.00	-3	316.	76.0	4.2	1
909HC	FSC	0.10	-2	210.	35.0	6.0	1
909HC	FSC	0.10	-2	231.	35.0	6.6	1
909HC	FSC	0.10	3	1092.	140.0	7.8	1
909HC	FSC	0.10	3	1305.	145.0	9.0	1
909HC	FSC	0.10	3	998.	128.0	7.8	1
909HC	FSC	0.10	3	1274.	140.0	9.1	1
909HC	FSC	1.00	-1	95.	56.0	1.7	1
909HC	FSC	1.00	-1	110.	55.2	2.0	1
909HC	FSC	1.00	-1	54.	71.0	0.8	1
909HC	FSC	1.00	-1	67.	48.0	1.4	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
910HC	FSC	10.00	1	19.	96.0	0.2	1
910HC	FSC	10.00	1	13.	44.4	0.5	1
910HC	FSC	10.00	1	24.	79.0	0.3	1
910HC	FSC	10.00	1	13.	30.4	0.5	1
910HC	FSC	10.00	-1	8.	99.0	0.1	1
910HC	FSC	10.00	-1	18.	84.3	0.4	1
910HC	FSC	10.00	-1	7.	80.0	0.1	1
910HC	FSC	10.00	-1	17.	80.0	0.3	1
910HC	FSC	1.00	-1	25.	108.0	0.2	1
910HC	FSC	1.00	-1	24.	85.5	0.5	1
910HC	FSC	1.00	-1	25.	126.0	0.2	1
910HC	FSC	1.00	-1	73.	106.0	1.1	1
910HC	FSC	0.10	-1	234.	90.0	2.6	1
910HC	FSC	0.10	-1	279.	90.0	3.1	1
910HC	FSC	10.00	2	37.	32.4	1.2	1
910HC	FSC	10.00	2	16.	10.5	1.7	1
910HC	FSC	10.00	2	34.	33.0	1.0	1
910HC	FSC	10.00	2	30.	21.2	1.5	1
910HC	FSC	10.00	-2	20.	17.0	1.2	1
910HC	FSC	10.00	-2	17.	15.0	1.4	1
910HC	FSC	10.00	-2	17.	15.0	1.1	1
910HC	FSC	10.00	-2	18.	15.7	1.2	1
910HC	FSC	1.00	-2	48.	20.0	2.4	1
910HC	FSC	1.00	-2	48.	20.0	2.4	1
910HC	FSC	1.00	-2	36.	18.0	2.0	1
910HC	FSC	1.00	-2	42.	19.0	2.2	1
910HC	FSC	0.10	-2	126.	28.0	4.5	1
910HC	FSC	0.10	-2	160.	32.0	5.0	1
910HC	FSC	0.10	-2	160.	38.0	4.2	1
910HC	FSC	0.10	-2	216.	45.0	4.8	1
910HC	FSC	10.00	3	53.	87.1	0.7	1
910HC	FSC	10.00	3	54.	30.9	2.0	1
910HC	FSC	10.00	3	78.	86.4	1.0	1
910HC	FSC	10.00	3	91.	64.2	1.4	1
910HC	FSC	10.00	-3	66.	41.0	1.6	1
910HC	FSC	10.00	-3	60.	31.5	2.0	1
910HC	FSC	10.00	-3	67.	42.0	1.6	1
910HC	FSC	10.00	-3	73.	40.0	1.9	1
910HC	FSC	1.00	-3	218.	64.0	3.4	1
910HC	FSC	1.00	-3	231.	59.4	3.9	1
910HC	FSC	1.00	-3	224.	64.0	3.5	1
910HC	FSC	1.00	-3	235.	61.6	3.9	1
910HC	FSC	0.10	-3	1080.	135.0	8.0	1
910HC	FSC	0.10	-3	1470.	150.0	9.8	1
910HC	FSC	0.10	-3	1056.	132.0	8.0	1
910HC	FSC	0.10	-3	1414.	140.0	10.1	1
910HC	FSC	0.10	3	375.	163.0	2.3	1
910HC	FSC	0.10	3	478.	160.0	3.0	1
910HC	FSC	0.10	3	342.	163.0	2.1	1
910HC	FSC	0.10	3	514.	165.5	3.3	1
910HC	FSC	1.00	3	164.	129.0	1.3	1
910HC	FSC	1.00	3	181.	94.0	2.2	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
910HC	FSC	1.00	3	164.	129.0	1.3	1
910HC	FSC	1.00	3	183.	77.0	2.6	1
910HC	FSC	10.00	-1	48.	44.0	1.1	1
910HC	FSC	10.00	-1	33.	23.4	1.7	1
910HC	FSC	10.00	-1	44.	42.0	1.0	1
910HC	FSC	10.00	-1	46.	37.6	1.3	1
911HC	FSC	10.00	1	19.	95.0	0.2	1
911HC	FSC	10.00	1	27.	58.0	1.2	1
911HC	FSC	10.00	1	64.	80.0	0.8	1
911HC	FSC	10.00	1	52.	55.2	1.5	1
911HC	FSC	10.00	1	54.	77.0	0.7	1
911HC	FSC	10.00	1	44.	43.4	1.7	1
911HC	FSC	10.00	-1	9.	107.6	0.1	1
911HC	FSC	10.00	-1	23.	16.4	1.6	1
911HC	FSC	10.00	-1	11.	104.1	0.1	1
911HC	FSC	10.00	-1	26.	17.4	1.8	1
911HC	FSC	1.00	-1	45.	46.0	1.0	1
911HC	FSC	1.00	-1	67.	48.0	1.4	1
911HC	FSC	1.00	-1	97.	74.0	1.7	1
911HC	FSC	1.00	-1	97.	44.0	2.3	1
911HC	FSC	1.00	-1	58.	118.5	0.8	1
911HC	FSC	1.00	-1	74.	30.8	2.7	1
911HC	FSC	0.10	-1	157.	131.5	1.5	1
911HC	FSC	0.10	-1	240.	80.0	3.0	1
911HC	FSC	0.10	-1	225.	75.0	3.0	1
911HC	FSC	0.10	-1	272.	85.0	3.2	1
911HC	FSC	10.00	2	29.	44.6	0.8	1
911HC	FSC	10.00	2	33.	29.0	1.3	1
911HC	FSC	10.00	2	32.	41.6	0.9	1
911HC	FSC	10.00	2	32.	35.0	1.2	1
911HC	FSC	10.00	-2	17.	16.5	1.0	1
911HC	FSC	10.00	-2	14.	11.9	1.2	1
911HC	FSC	10.00	-2	18.	17.0	1.0	1
911HC	FSC	10.00	-2	17.	13.7	1.3	1
911HC	FSC	1.00	-2	21.	19.0	1.1	1
911HC	FSC	1.00	-2	32.	23.0	1.4	1
911HC	FSC	1.00	-2	18.	16.5	1.1	1
911HC	FSC	1.00	-2	25.	19.5	1.3	1
911HC	FSC	0.10	-2	35.	22.0	1.6	1
911HC	FSC	0.10	-2	56.	28.0	2.0	1
911HC	FSC	0.10	-2	55.	26.0	2.1	1
911HC	FSC	0.10	-2	62.	28.0	2.2	1
911HC	FSC	10.00	3	67.	26.5	2.6	1
911HC	FSC	10.00	3	76.	29.6	2.6	1
911HC	FSC	10.00	3	85.	35.3	2.4	1
911HC	FSC	10.00	3	80.	30.0	2.7	1
911HC	FSC	10.00	-3	49.	38.0	1.3	1
911HC	FSC	10.00	-3	50.	31.4	1.6	1
911HC	FSC	10.00	-3	57.	38.0	1.5	1
911HC	FSC	10.00	-3	64.	38.8	1.6	1
911HC	FSC	1.00	-3	208.	60.8	3.4	1
911HC	FSC	1.00	-3	203.	55.8	3.7	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
911HC	FSC	1.00	-3	234.	59.2	4.0	1
911HC	FSC	1.00	-3	223.	54.0	4.2	1
911HC	FSC	0.10	-3	936.	120.0	7.8	1
911HC	FSC	0.10	-3	1134.	135.0	8.4	1
911HC	FSC	0.10	-3	870.	128.0	6.8	1
911HC	FSC	0.10	-3	1040.	130.0	8.0	1
911HC	FSC	0.10	-2	67.	29.0	2.3	1
911HC	FSC	0.10	-2	84.	30.0	2.8	1
912HC	FSC	10.00	-1	106.	110.5	1.0	1
912HC	FSC	10.00	-1	121.	117.3	1.0	1
912HC	FSC	10.00	-1	88.	99.0	0.9	1
912HC	FSC	10.00	-1	105.	107.0	1.0	1
912HC	FSC	10.00	1	74.	57.5	1.3	1
912HC	FSC	10.00	1	86.	58.4	1.5	1
912HC	FSC	10.00	1	44.	168.5	0.3	1
912HC	FSC	10.00	1	66.	150.0	0.8	1
912HC	FSC	10.00	1	34.	160.0	0.2	1
912HC	FSC	10.00	1	66.	84.0	1.8	1
912HC	FSC	1.00	-1	247.	146.0	1.7	1
912HC	FSC	1.00	-1	262.	146.8	1.8	1
912HC	FSC	1.00	1	298.	192.0	1.9	1
912HC	FSC	1.00	1	146.	275.0	0.5	1
912HC	FSC	1.00	1	193.	207.0	1.2	1
912HC	FSC	1.00	1	150.	123.9	1.6	1
912HC	FSC	0.10	1	1330.	325.0	4.4	1
912HC	FSC	0.10	1	1595.	330.0	5.3	1
912HC	FSC	0.10	1	1515.	312.5	5.2	1
912HC	FSC	0.10	1	1648.	297.5	6.1	1
912HC	FSC	10.00	2	39.	31.0	1.3	1
912HC	FSC	10.00	2	40.	29.8	1.4	1
912HC	FSC	10.00	2	25.	27.8	1.0	1
912HC	FSC	10.00	2	32.	26.4	1.3	1
912HC	FSC	10.00	-2	17.	15.0	1.1	1
912HC	FSC	10.00	-2	17.	14.4	1.2	1
912HC	FSC	10.00	-2	19.	15.5	1.2	1
912HC	FSC	10.00	-2	19.	13.8	1.4	1
912HC	FSC	1.00	-2	92.	40.0	2.3	1
912HC	FSC	1.00	-2	103.	40.8	2.5	1
912HC	FSC	1.00	-2	88.	34.0	2.6	1
912HC	FSC	1.00	-2	95.	35.0	2.7	1
912HC	FSC	10.00	3	99.	55.0	1.8	1
912HC	FSC	10.00	3	120.	60.0	2.0	1
912HC	FSC	10.00	3	33.	86.0	0.4	1
912HC	FSC	10.00	3	78.	72.4	1.3	1
912HC	FSC	10.00	3	26.	128.0	0.2	1
912HC	FSC	10.00	3	61.	110.0	0.6	1
912HC	FSC	10.00	-3	242.	105.0	2.3	1
912HC	FSC	10.00	-3	223.	79.0	3.0	1
912HC	FSC	10.00	-3	218.	128.0	1.7	1
912HC	FSC	10.00	-3	197.	78.6	2.7	1
912HC	FSC	1.00	3	173.	72.8	2.5	1
912HC	FSC	1.00	3	177.	71.0	2.5	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
912HC	FSC	1.00	3	57.	190.0	0.3	1
912HC	FSC	1.00	3	128.	114.8	1.9	1
912HC	FSC	1.00	3	190.	71.0	2.7	1
912HC	FSC	1.00	3	203.	69.6	3.0	1
912HC	FSC	0.10	3	720.	90.0	8.0	1
912HC	FSC	0.10	3	1134.	135.0	8.4	1
912HC	FSC	0.10	3	720.	80.0	9.0	1
912HC	FSC	0.10	3	816.	85.0	9.6	1
912HC	FSC	0.10	-2	78.	30.0	2.6	1
912HC	FSC	0.10	-2	101.	36.0	2.8	1
912HC	FSC	1.00	-2	60.	26.0	2.3	1
912HC	FSC	1.00	-2	72.	30.0	2.4	1
912HC	FSC	0.10	-1	853.	158.0	5.4	1
912HC	FSC	0.10	-1	836.	123.0	6.8	1
930HC	FSC	10.00	-1	37.	45.9	0.8	1
930HC	FSC	10.00	-1	48.	51.1	1.0	1
930HC	FSC	10.00	-1	23.	36.6	0.6	1
930HC	FSC	10.00	-1	36.	43.2	0.8	1
930HC	FSC	10.00	1	6.	25.5	0.2	1
930HC	FSC	10.00	1	9.	23.8	0.4	1
930HC	FSC	10.00	1	8.	21.0	0.4	1
930HC	FSC	10.00	1	10.	22.0	0.4	1
930HC	FSC	1.00	1	30.	36.0	0.8	1
930HC	FSC	1.00	1	32.	27.0	1.3	1
930HC	FSC	1.00	1	31.	30.5	1.0	1
930HC	FSC	1.00	1	40.	34.5	1.2	1
930HC	FSC	0.10	1	71.	62.5	1.2	1
930HC	FSC	0.10	1	92.	53.3	1.8	1
930HC	FSC	0.10	1	89.	51.0	1.8	1
930HC	FSC	0.10	1	96.	55.0	1.7	1
930HC	FSC	10.00	-2	27.	14.0	1.9	1
930HC	FSC	10.00	-2	32.	14.6	2.2	1
930HC	FSC	10.00	-2	21.	13.0	1.6	1
930HC	FSC	10.00	-2	25.	13.4	1.9	1
930HC	FSC	10.00	2	14.	19.0	0.8	1
930HC	FSC	10.00	2	15.	15.8	1.0	1
930HC	FSC	10.00	2	21.	16.7	1.3	1
930HC	FSC	10.00	2	20.	15.3	1.3	1
930HC	FSC	1.00	2	37.	20.3	1.8	1
930HC	FSC	1.00	2	39.	19.0	2.1	1
930HC	FSC	1.00	2	26.	22.7	1.2	1
930HC	FSC	1.00	2	30.	23.8	1.2	1
930HC	FSC	0.10	2	180.	53.0	3.4	1
930HC	FSC	0.10	2	213.	56.0	3.8	1
930HC	FSC	0.10	2	212.	53.0	4.0	1
930HC	FSC	0.10	2	258.	60.0	4.3	1
930HC	FSC	10.00	-3	30.	23.7	1.3	1
930HC	FSC	10.00	-3	32.	22.4	1.5	1
930HC	FSC	10.00	-3	32.	21.0	1.5	1
930HC	FSC	10.00	-3	35.	22.0	1.6	1
930HC	FSC	10.00	3	27.	14.0	1.9	1
930HC	FSC	10.00	3	27.	11.8	2.3	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
930HC	FSC	10.00	3	29.	14.0	2.1	1
930HC	FSC	10.00	3	32.	13.4	2.4	1
930HC	FSC	1.00	3	52.	18.0	2.9	1
930HC	FSC	1.00	3	56.	18.0	3.1	1
930HC	FSC	1.00	3	38.	15.0	2.5	1
930HC	FSC	1.00	3	49.	16.4	3.0	1
930HC	FSC	1.00	-3	38.	25.0	1.5	1
930HC	FSC	1.00	-3	50.	28.0	1.8	1
930HC	FSC	0.10	3	228.	35.0	6.5	1
930HC	FSC	0.10	3	280.	40.0	7.0	1
930HC	FSC	0.10	3	216.	36.0	6.0	1
930HC	FSC	0.10	3	215.	33.0	6.5	1
930HC	FSC	10.00	-2	24.	14.0	1.7	1
930HC	FSC	10.00	-2	27.	14.2	1.9	1
930RC	RSC	10.00	1	18.	45.0	0.4	1
930RC	RSC	10.00	1	17.	25.0	0.9	1
930RC	RSC	10.00	-1	12.	26.4	0.4	1
930RC	RSC	10.00	-1	13.	18.7	0.7	1
930RC	RSC	1.00	1	30.	28.4	1.1	1
930RC	RSC	1.00	1	36.	27.0	1.4	1
930RC	RSC	0.10	1	196.	56.0	3.5	1
930RC	RSC	0.10	1	228.	60.0	3.8	1
930RC	RSC	10.00	-2	15.	13.5	1.1	1
930RC	RSC	10.00	-2	13.	10.4	1.3	1
930RC	RSC	10.00	2	23.	21.2	1.1	1
930RC	RSC	10.00	2	30.	22.9	1.4	1
930RC	RSC	1.00	-2	43.	17.0	2.5	1
930RC	RSC	1.00	-2	64.	23.0	2.8	1
930RC	RSC	1.00	-2	41.	17.0	2.4	1
930RC	RSC	1.00	-2	64.	23.0	2.8	1
930RC	RSC	0.10	-2	462.	44.0	10.5	1
930RC	RSC	0.10	-2	542.	48.0	11.3	1
930RC	RSC	0.10	-2	462.	44.0	10.5	1
930RC	RSC	0.10	-2	565.	50.0	11.3	1
930RC	RSC	10.00	-3	152.	155.0	1.0	1
930RC	RSC	10.00	-3	154.	134.0	1.3	1
930RC	RSC	10.00	-3	147.	150.0	1.0	1
930RC	RSC	10.00	-3	146.	141.2	1.1	1
930RC	RSC	10.00	3	51.	113.0	0.5	1
930RC	RSC	10.00	3	35.	47.4	0.9	1
930RC	RSC	10.00	3	50.	120.7	0.4	1
930RC	RSC	10.00	3	48.	90.4	0.6	1
930RC	RSC	1.00	3	256.	116.0	2.5	1
930RC	RSC	1.00	3	243.	86.0	3.8	1
930RC	RSC	1.00	3	360.	150.0	2.4	1
930RC	RSC	1.00	3	416.	160.0	2.6	1
930RC	RSC	0.10	3	1008.	240.0	4.2	1
930RC	RSC	0.10	3	1352.	260.0	5.2	1
930RC	RSC	0.10	3	1058.	230.0	4.6	1
930RC	RSC	0.10	3	1352.	260.0	5.2	1
930RC	RSC	10.00	-2	14.	13.5	1.0	1
930RC	RSC	10.00	-2	14.	11.6	1.2	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
930RC	RSC	10.00	-2	9.	12.0	0.8	1
930RC	RSC	10.00	-2	11.	11.4	1.0	1
930RC	RSC	10.00	2	27.	31.8	0.9	1
930RC	RSC	10.00	2	27.	22.5	1.2	1
930RC	RSC	1.00	2	53.	48.0	1.1	1
930RC	RSC	1.00	2	40.	24.8	1.6	1
930RC	RSC	10.00	1	8.	20.3	0.4	1
930RC	RSC	10.00	1	9.	20.2	0.4	1
930RC	RSC	1.00	1	27.	25.2	1.1	1
930RC	RSC	1.00	1	40.	28.9	1.4	1
930RC	RSC	1.00	1	28.	25.7	1.1	1
930RC	RSC	1.00	1	27.	25.2	1.1	1
930RC	RSC	0.10	1	134.	48.0	2.8	1
930RC	RSC	1.00	1	163.	51.0	3.2	1
932HC	FSC	10.00	-1	49.	45.0	1.1	1
932HC	FSC	10.00	-1	58.	48.0	1.2	1
932HC	FSC	10.00	-1	55.	50.0	1.1	1
932HC	FSC	10.00	-1	73.	52.0	1.4	1
932HC	FSC	10.00	1	14.	18.5	0.8	1
932HC	FSC	10.00	1	17.	16.6	1.0	1
932HC	FSC	1.00	1	32.	37.0	0.9	1
932HC	FSC	1.00	1	37.	33.0	1.2	1
932HC	FSC	1.00	1	28.	32.0	0.9	1
932HC	FSC	1.00	1	30.	29.0	1.1	1
932HC	FSC	1.00	1	36.	27.0	1.4	1
932HC	FSC	1.00	1	52.	36.0	1.5	1
932HC	FSC	1.00	1	42.	26.6	1.6	1
932HC	FSC	0.10	1	58.	48.0	1.2	1
932HC	FSC	0.10	1	77.	55.0	1.4	1
932HC	FSC	0.10	1	52.	40.0	1.3	1
932HC	FSC	0.10	1	68.	45.0	1.5	1
932HC	FSC	10.00	-2	17.	13.0	1.3	1
932HC	FSC	10.00	-2	23.	13.3	1.7	1
932HC	FSC	10.00	-2	17.	13.0	1.3	1
932HC	FSC	10.00	-2	23.	13.4	1.7	1
932HC	FSC	10.00	2	24.	23.4	1.0	1
932HC	FSC	10.00	2	30.	27.1	1.1	1
932HC	FSC	10.00	2	18.	19.5	0.9	1
932HC	FSC	10.00	2	12.	8.1	1.6	1
932HC	FSC	1.00	2	30.	25.0	1.2	1
932HC	FSC	1.00	2	43.	28.4	1.5	1
932HC	FSC	1.00	2	47.	39.0	1.2	1
932HC	FSC	1.00	2	41.	25.3	1.7	1
932HC	FSC	1.00	-2	44.	17.0	2.6	1
932HC	FSC	1.00	-2	61.	19.0	3.2	1
932HC	FSC	0.10	2	240.	40.0	6.0	1
932HC	FSC	0.10	2	350.	50.0	7.0	1
932HC	FSC	0.10	2	260.	40.0	6.5	1
932HC	FSC	0.10	2	315.	45.0	7.0	1
932HC	FSC	10.00	-3	139.	43.5	3.2	1
932HC	FSC	10.00	-3	148.	42.0	3.5	1
932HC	FSC	10.00	-3	187.	48.0	3.9	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
932HC	FSC	10.00	-3	170.	39.9	3.0	1
932HC	FSC	10.00	3	30.	21.0	1.5	1
932HC	FSC	10.00	3	30.	16.9	1.8	1
932HC	FSC	10.00	3	21.	17.0	1.3	1
932HC	FSC	10.00	3	38.	23.1	1.7	1
932HC	FSC	1.00	3	41.	34.0	1.2	1
932HC	FSC	1.00	3	46.	27.8	1.7	1
932HC	FSC	1.00	3	48.	26.0	1.9	1
932HC	FSC	1.00	3	49.	25.0	2.0	1
932HC	FSC	0.10	3	185.	42.0	4.4	1
932HC	FSC	0.10	3	235.	47.0	5.0	1
932HC	FSC	0.10	3	160.	42.0	3.8	1
932HC	FSC	0.10	3	202.	44.0	4.6	1
932HC	FSC	10.00	4	17.	14.0	1.2	1
932HC	FSC	10.00	4	18.	12.9	1.4	1
932HC	FSC	10.00	4	15.	13.0	1.1	1
932HC	FSC	10.00	4	16.	11.6	1.4	1
932HC	FSC	10.00	-4	49.	54.0	0.9	1
932HC	FSC	10.00	-4	31.	21.6	1.6	1
932HC	FSC	10.00	-4	51.	44.3	1.2	1
932HC	FSC	10.00	-4	29.	17.5	1.8	1
932HC	FSC	1.00	4	34.	21.0	1.6	1
932HC	FSC	1.00	4	41.	21.2	1.9	1
932HC	FSC	1.00	4	41.	20.4	2.0	1
932HC	FSC	1.00	4	48.	22.0	2.2	1
932HC	FSC	0.10	4	235.	42.0	5.6	1
932HC	FSC	0.10	4	302.	45.0	6.7	1
932HC	FSC	0.10	4	343.	47.0	7.3	1
932HC	FSC	0.10	4	343.	47.0	7.3	1
933HC	FSC	10.00	-1	32.	40.8	0.8	1
933HC	FSC	10.00	-1	55.	47.0	1.2	1
933HC	FSC	10.00	-1	43.	42.8	1.0	1
933HC	FSC	10.00	-1	50.	46.6	1.1	1
933HC	FSC	10.00	1	22.	108.0	0.2	1
933HC	FSC	10.00	1	38.	90.8	0.5	1
933HC	FSC	10.00	1	20.	99.0	0.2	1
933HC	FSC	10.00	1	40.	78.0	0.7	1
933HC	FSC	1.00	1	113.	72.5	1.6	1
933HC	FSC	1.00	1	122.	70.6	1.8	1
933HC	FSC	1.00	1	129.	87.5	1.5	1
933HC	FSC	1.00	1	132.	88.2	1.5	1
933HC	FSC	0.10	1	494.	160.0	3.1	1
933HC	FSC	0.10	1	774.	180.0	4.3	1
933HC	FSC	0.10	1	221.	105.0	2.1	1
933HC	FSC	0.10	1	543.	143.0	3.8	1
933HC	FSC	10.00	-2	42.	42.0	1.0	1
933HC	FSC	10.00	-2	49.	40.0	1.3	1
933HC	FSC	10.00	-2	75.	68.0	1.1	1
933HC	FSC	10.00	-2	84.	70.0	1.2	1
933HC	FSC	10.00	2	41.	63.0	0.7	1
933HC	FSC	10.00	2	46.	42.0	1.1	1
933HC	FSC	10.00	2	-1.	-1.0	-1.0	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
933HC	FSC	10.00	2	28.	78.6	0.5	1
933HC	FSC	1.00	2	142.	79.0	1.8	1
933HC	FSC	1.00	2	189.	90.0	2.1	1
933HC	FSC	1.00	2	42.	105.0	0.4	1
933HC	FSC	1.00	2	79.	95.0	0.9	1
933HC	FSC	0.10	2	270.	225.0	1.2	1
933HC	FSC	0.10	2	336.	240.0	1.4	1
DM933	NSC	10.00	-1	50.	104.0	0.5	1
DM933	NSC	10.00	-1	83.	104.1	0.8	1
DM933	NSC	10.00	1	54.	150.0	0.4	1
DM933	NSC	10.00	1	49.	131.5	0.4	1
DM933	NSC	10.00	1	-1.	-1.0	-1.0	1
DM933	NSC	10.00	1	59.	107.0	0.6	1
DM933	NSC	1.00	1	121.	130.0	0.9	1
DM933	NSC	1.00	1	149.	129.3	1.2	1
DM933	NSC	1.00	1	16.	113.0	0.1	1
DM933	NSC	1.00	1	58.	92.6	0.7	1
DM933	NSC	0.10	1	204.	340.0	0.6	1
DM933	NSC	0.10	1	489.	335.0	1.6	1
DM933	NSC	0.10	1	117.	260.0	0.5	1
DM933	NSC	0.10	1	182.	280.0	0.7	1
DM933	NSC	10.00	-2	49.	116.2	0.4	1
DM933	NSC	10.00	-2	66.	10[illegible].1	0.6	1
DM933	NSC	10.00	-2	74.	114.8	0.7	1
DM933	NSC	10.00	-2	95.	102.9	0.9	1
DM933	NSC	10.00	2	-1.	-1.0	-1.0	1
DM933	NSC	10.00	2	33.	109.6	0.3	1
DM933	NSC	10.00	2	47.	124.0	0.4	1
DM933	NSC	10.00	2	56.	117.1	0.5	1
DM933	NSC	1.00	2	40.	162.3	0.3	1
DM933	NSC	1.00	2	96.	140.7	0.7	1
DM933	NSC	1.00	2	107.	164.3	0.7	1
DM933	NSC	1.00	2	128.	158.3	0.8	1
DM933	NSC	0.10	2	520.	200.0	2.6	1
DM933	NSC	0.10	2	588.	210.0	2.8	1
DM933	NSC	0.10	2	360.	200.0	1.8	1
DM933	NSC	0.10	2	483.	210.0	2.3	1
944HC	FSC	10.00	-1	22.	38.5	0.6	1
944HC	FSC	10.00	-1	25.	23.7	1.1	1
944HC	FSC	10.00	-1	29.	38.8	0.8	1
944HC	FSC	10.00	-1	24.	17.7	1.4	1
944HC	FSC	10.00	1	8.	14.2	0.6	1
944HC	FSC	10.00	1	8.	14.0	0.6	1
944HC	FSC	10.00	1	7.	14.0	0.5	1
944HC	FSC	10.00	1	10.	15.6	0.6	1
944HC	FSC	1.00	1	21.	24.0	0.9	1
944HC	FSC	1.00	1	26.	24.2	1.1	1
944HC	FSC	1.00	1	29.	22.8	1.3	1
944HC	FSC	1.00	1	34.	24.5	1.4	1
944HC	FSC	0.10	1	72.	40.0	1.8	1
944HC	FSC	0.10	1	88.	42.0	2.1	1
944HC	FSC	0.10	1	81.	35.0	2.3	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
944HC	FSC	0.10	1	96.	37.0	2.6	1
944HC	FSC	10.00	2	26.	20.2	1.5	1
944HC	FSC	10.00	2	31.	18.1	1.8	1
944HC	FSC	10.00	2	32.	22.9	1.4	1
944HC	FSC	10.00	2	29.	17.8	1.7	1
944HC	FSC	10.00	-2	25.	11.0	2.3	1
944HC	FSC	10.00	-2	23.	8.6	2.6	1
944HC	FSC	10.00	-2	33.	11.0	3.0	1
944HC	FSC	10.00	-2	36.	11.7	3.1	1
944HC	FSC	1.00	-2	76.	14.0	5.4	1
944HC	FSC	1.00	-2	88.	14.9	5.9	1
944HC	FSC	1.00	-2	67.	14.0	4.8	1
944HC	FSC	1.00	-2	80.	15.0	5.3	1
944HC	FSC	1.00	2	83.	31.4	2.6	1
944HC	FSC	1.00	2	99.	32.3	3.1	1
944HC	FSC	1.00	2	111.	37.0	3.0	1
944HC	FSC	1.00	2	136.	40.0	3.4	1
944HC	FSC	10.00	-3	152.	52.5	2.9	1
944HC	FSC	10.00	-3	150.	49.0	3.1	1
944HC	FSC	10.00	-3	150.	53.5	2.8	1
944HC	FSC	10.00	-3	43.	14.3	0.9	1
944HC	FSC	10.00	3	15.	64.0	0.2	1
944HC	FSC	10.00	3	34.	67.0	0.6	1
944HC	FSC	10.00	3	20.	80.0	0.3	1
944HC	FSC	10.00	3	33.	67.0	0.6	1
944HC	FSC	1.00	3	163.	96.0	1.7	1
944HC	FSC	1.00	3	177.	97.4	1.8	1
944HC	FSC	1.00	3	169.	61.5	2.8	1
944HC	FSC	1.00	3	180.	61.0	3.0	1
944HC	FSC	0.10	3	434.	140.0	3.1	1
944HC	FSC	0.10	3	636.	163.0	3.9	1
944HC	FSC	0.10	3	685.	163.0	4.2	1
944HC	FSC	0.10	3	782.	163.0	4.8	1
944HC	FSC	10.00	-4	27.	34.6	0.8	1
944HC	FSC	10.00	-4	21.	19.2	1.2	1
944HC	FSC	10.00	-4	26.	40.0	0.6	1
944HC	FSC	10.00	-4	22.	20.4	1.2	1
944HC	FSC	10.00	4	10.	11.2	0.9	1
944HC	FSC	10.00	4	15.	13.5	1.1	1
944HC	FSC	10.00	4	12.	12.4	1.0	1
944HC	FSC	10.00	4	14.	12.5	1.1	1
944HC	FSC	1.00	4	35.	24.5	1.5	1
944HC	FSC	1.00	4	44.	25.7	1.7	1
944HC	FSC	1.00	4	29.	19.0	1.6	1
944HC	FSC	1.00	4	34.	17.5	2.0	1
944HC	FSC	0.10	4	168.	40.0	4.2	1
944HC	FSC	0.10	4	233.	53.0	4.4	1
944HC	FSC	0.10	4	164.	42.0	3.9	1
944HC	FSC	0.10	4	185.	42.0	4.4	1
DM944	NSC	10.00	-1	23.	45.0	0.5	1
DM944	NSC	10.00	-1	25.	47.0	0.5	1
DM944	NSC	10.00	-1	15.	38.0	0.4	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
DM944	NSC	10.00	-1	20.	40.8	0.5	1
DM944	NSC	10.00	1	6.	16.6	0.3	1
DM944	NSC	10.00	1	10.	15.4	0.6	1
DM944	NSC	10.00	1	11.	28.1	0.4	1
DM944	NSC	10.00	1	13.	14.6	0.9	1
DM944	NSC	1.00	1	22.	28.0	0.8	1
DM944	NSC	1.00	1	23.	23.0	1.0	1
DM944	NSC	1.00	1	23.	31.0	0.8	1
DM944	NSC	1.00	1	21.	22.9	0.9	1
DM944	NSC	0.10	1	86.	54.0	1.6	1
DM944	NSC	0.10	1	97.	54.0	1.8	1
DM944	NSC	0.10	1	113.	63.0	1.8	1
DM944	NSC	0.10	1	154.	77.0	2.0	1
DM944	NSC	10.00	2	41.	15.5	2.7	1
DM944	NSC	10.00	2	54.	18.7	2.9	1
DM944	NSC	10.00	2	30.	16.2	1.9	1
DM944	NSC	10.00	2	42.	18.2	2.3	1
DM944	NSC	10.00	-2	18.	11.0	1.6	1
DM944	NSC	10.00	-2	23.	10.1	2.3	1
DM944	NSC	10.00	-2	30.	13.5	2.3	1
DM944	NSC	10.00	-2	23.	11.3	2.4	1
DM944	NSC	1.00	-2	60.	17.0	3.5	1
DM944	NSC	1.00	-2	87.	17.0	5.1	1
DM944	NSC	1.00	-2	60.	17.0	3.5	1
DM944	NSC	1.00	-2	53.	14.0	3.8	1
DM944	NSC	0.10	-2	315.	37.0	8.5	1
DM944	NSC	0.10	-2	353.	36.0	9.8	1
DM944	NSC	10.00	-3	44.	45.6	1.0	1
DM944	NSC	10.00	-3	54.	43.4	1.3	1
DM944	NSC	10.00	-3	55.	41.7	1.3	1
DM944	NSC	10.00	-3	58.	32.1	1.8	1
DM944	NSC	10.00	3	14.	75.0	0.2	1
DM944	NSC	10.00	3	14.	66.1	0.3	1
DM944	NSC	10.00	3	14.	80.0	0.2	1
DM944	NSC	10.00	3	10.	49.1	0.3	1
DM944	NSC	1.00	3	22.	80.0	0.3	1
DM944	NSC	1.00	3	29.	96.0	0.6	1
DM944	NSC	10.00	-4	31.	52.4	0.6	1
DM944	NSC	10.00	-4	32.	42.7	0.8	1
DM944	NSC	10.00	-4	35.	44.3	0.8	1
DM944	NSC	10.00	-4	49.	47.5	1.0	1
DM944	NSC	10.00	4	7.	10.7	0.7	1
DM944	NSC	10.00	4	7.	11.6	5.6	1
DM944	NSC	10.00	4	7.	11.4	0.6	1
DM944	NSC	10.00	4	7.	10.5	0.7	1
DM944	NSC	1.00	4	15.	15.8	1.0	1
DM944	NSC	1.00	4	17.	14.7	1.1	1
DM944	NSC	1.00	4	19.	20.7	0.9	1
DM944	NSC	1.00	4	18.	17.4	0.9	1
DM944	NSC	0.10	4	118.	42.0	2.8	1
DM944	NSC	0.10	4	138.	46.0	3.0	1
DM944	NSC	0.10	4	62.	44.0	1.4	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
DM944	NSC	0.10	4	100.	50.0	2.0	1
945HC	FSC	10.00	-1	15.	32.0	0.5	1
945HC	FSC	10.00	-1	22.	35.8	0.6	1
945HC	FSC	10.00	-1	25.	36.4	0.7	1
945HC	FSC	10.00	-1	23.	26.2	0.6	1
945HC	FSC	10.00	1	14.	24.0	0.6	1
945HC	FSC	10.00	1	17.	26.4	0.7	1
945HC	FSC	10.00	1	12.	20.3	0.6	1
945HC	FSC	10.00	1	14.	22.2	0.6	1
945HC	FSC	1.00	1	42.	38.0	1.1	1
945HC	FSC	1.00	1	50.	37.6	1.3	1
945HC	FSC	1.00	1	40.	32.1	1.3	1
945HC	FSC	1.00	1	49.	36.8	1.3	1
945HC	FSC	0.10	1	105.	50.0	2.1	1
945HC	FSC	0.10	1	132.	60.0	2.2	1
945HC	FSC	0.10	1	74.	35.0	2.1	1
945HC	FSC	0.10	1	119.	54.0	2.2	1
945HC	FSC	10.00	2	16.	21.2	0.7	1
945HC	FSC	10.00	2	16.	18.6	0.9	1
945HC	FSC	10.00	2	13.	21.8	0.6	1
945HC	FSC	10.00	2	13.	17.7	0.7	1
945HC	FSC	10.00	-2	6.	8.6	0.7	1
945HC	FSC	10.00	-2	4.	4.8	0.8	1
945HC	FSC	1.00	-2	24.	17.0	1.4	1
945HC	FSC	1.00	-2	37.	23.0	1.6	1
945HC	FSC	0.10	-2	210.	30.0	7.0	1
945HC	FSC	0.10	-2	296.	40.0	7.4	1
945HC	FSC	0.10	-2	231.	35.0	6.6	1
945HC	FSC	0.10	-2	390.	50.0	7.8	1
945HC	FSC	10.00	3	109.	84.0	1.3	1
945HC	FSC	10.00	3	139.	81.6	1.7	1
945HC	FSC	10.00	3	109.	79.4	1.4	1
945HC	FSC	10.00	3	133.	75.4	1.8	1
945HC	FSC	10.00	-3	110.	53.8	2.1	1
945HC	FSC	10.00	-3	119.	48.8	2.5	1
945HC	FSC	10.00	-3	99.	56.5	1.8	1
945HC	FSC	10.00	-3	110.	56.6	1.9	1
945HC	FSC	1.00	-3	213.	60.0	3.6	1
945HC	FSC	1.00	-3	254.	66.0	3.9	1
945HC	FSC	1.00	-3	259.	72.0	3.6	1
945HC	FSC	1.00	-3	282.	68.0	4.2	1
945HC	FSC	10.00	-2	6.	6.5	0.9	1
945HC	FSC	10.00	-2	7.	7.0	1.0	1
945HC	FSC	1.00	-2	42.	13.0	3.2	1
945HC	FSC	1.00	-2	49.	13.5	3.6	1
945HC	FSC	0.10	3	960.	120.0	8.0	1
945HC	FSC	0.10	3	1063.	125.0	8.5	1
945HC	FSC	1.00	3	218.	75.0	2.9	1
945HC	FSC	1.00	3	272.	85.0	3.2	1
945HC	FSC	1.00	3	204.	80.5	2.6	1
945HC	FSC	1.00	3	198.	69.6	3.0	1
DM945	NSC	10.00	-1	19.	35.5	0.5	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
DM945	NSC	10.00	-1	14.	24.4	0.4	1
DM945	NSC	10.00	-1	15.	34.4	0.4	1
DM945	NSC	10.00	-1	19.	35.8	0.5	1
DM945	NSC	10.00	1	11.	28.0	0.4	1
DM945	NSC	10.00	1	10.	24.9	0.4	1
DM945	NSC	10.00	1	5.	19.4	0.2	1
DM945	NSC	10.00	1	9.	21.5	0.4	1
DM945	NSC	10.00	1	19.	32.0	0.6	1
DM945	NSC	10.00	1	29.	33.0	0.9	1
DM945	NSC	1.00	1	29.	36.0	0.8	1
DM945	NSC	1.00	1	28.	33.8	0.8	1
DM945	NSC	0.10	1	138.	60.0	2.3	1
DM945	NSC	0.10	1	210.	75.0	2.8	1
DM945	NSC	0.10	1	57.	44.0	1.3	1
DM945	NSC	0.10	1	82.	48.0	1.7	1
DM945	NSC	10.00	2	13.	17.4	0.8	1
DM945	NSC	10.00	2	12.	9.1	1.5	1
DM945	NSC	10.00	2	17.	15.0	1.1	1
DM945	NSC	10.00	2	11.	8.5	1.3	1
DM945	NSC	10.00	2	23.	21.0	1.1	1
DM945	NSC	10.00	2	13.	10.8	1.4	1
DM945	NSC	10.00	-2	14.	11.0	1.3	1
DM945	NSC	10.00	-2	18.	11.0	1.6	1
DM945	NSC	10.00	-2	21.	11.5	1.8	1
DM945	NSC	10.00	-2	18.	9.1	2.0	1
DM945	NSC	1.00	-2	29.	12.0	2.4	1
DM945	NSC	1.00	-2	42.	16.2	2.6	1
DM945	NSC	1.00	-2	39.	14.0	2.8	1
DM945	NSC	1.00	-2	35.	11.7	3.0	1
DM945	NSC	0.10	2	207.	53.0	3.9	1
DM945	NSC	0.10	2	207.	45.0	4.6	1
DM945	NSC	10.00	3	69.	52.6	1.3	1
DM945	NSC	10.00	3	80.	51.8	1.6	1
DM945	NSC	10.00	3	53.	49.3	1.1	1
DM945	NSC	10.00	3	60.	45.4	1.3	1
DM945	NSC	10.00	-3	98.	47.8	2.0	1
DM945	NSC	10.00	-3	66.	28.9	2.4	1
DM945	NSC	10.00	-3	74.	40.8	1.8	1
DM945	NSC	10.00	-3	81.	39.6	2.1	1
DM945	NSC	1.00	-3	692.	94.0	7.4	1
DM945	NSC	1.00	-3	870.	104.0	8.4	1
DM945	NSC	1.00	3	223.	84.8	2.7	1
DM945	NSC	1.00	3	277.	90.5	3.1	1
DM945	NSC	1.00	3	226.	85.5	2.7	1
DM945	NSC	1.00	3	253.	86.0	3.0	1
DM945	NSC	0.10	3	576.	150.0	4.2	1
DM945	NSC	0.10	3	468.	90.0	5.2	1
DM945	NSC	0.10	3	929.	162.0	5.9	1
DM945	NSC	0.10	3	1036.	166.5	6.4	1
946HC	FSC	10.00	-1	36.	38.0	1.0	1
946HC	FSC	10.00	-1	49.	44.0	1.1	1
946HC	FSC	10.00	-1	40.	40.0	1.0	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
946HC	FSC	10.00	-1	57.	45.5	1.3	1
946HC	FSC	10.00	1	22.	43.0	0.5	1
946HC	FSC	10.00	1	15.	22.8	0.4	1
946HC	FSC	10.00	1	12.	27.2	0.4	1
946HC	FSC	10.00	1	13.	25.6	0.5	1
946HC	FSC	1.00	1	74.	62.0	1.2	1
946HC	FSC	1.00	1	91.	65.2	1.4	1
946HC	FSC	1.00	1	77.	62.0	1.3	1
946HC	FSC	1.00	1	91.	65.0	1.4	1
946HC	FSC	0.10	1	542.	113.0	4.8	1
946HC	FSC	0.10	1	648.	120.0	5.4	1
946HC	FSC	0.10	1	254.	106.0	2.4	1
946HC	FSC	0.10	1	588.	113.0	5.2	1
946HC	FSC	10.00	-2	14.	10.0	1.4	1
946HC	FSC	10.00	-2	9.	6.0	1.4	1
946HC	FSC	10.00	-2	10.	9.1	1.1	1
946HC	FSC	10.00	-2	9.	6.6	1.4	1
946HC	FSC	10.00	2	20.	24.0	0.9	1
946HC	FSC	10.00	2	23.	22.4	1.0	1
946HC	FSC	1.00	-2	31.	12.0	2.6	1
946HC	FSC	1.00	-2	38.	13.0	2.9	1
946HC	FSC	1.00	-2	30.	12.0	2.5	1
946HC	FSC	1.00	-2	36.	13.0	2.8	1
946HC	FSC	10.00	-3	114.	44.0	2.6	1
946HC	FSC	10.00	-3	114.	39.6	2.9	1
946HC	FSC	10.00	-3	163.	38.0	4.3	1
946HC	FSC	10.00	-3	188.	40.8	4.6	1
946HC	FSC	10.00	3	65.	66.0	1.0	1
946HC	FSC	10.00	3	78.	50.4	1.7	1
946HC	FSC	10.00	3	66.	51.0	1.3	1
946HC	FSC	10.00	3	86.	52.0	1.7	1
946HC	FSC	1.00	3	200.	95.0	2.1	1
946HC	FSC	1.00	3	206.	72.5	2.9	1
946HC	FSC	1.00	3	204.	68.0	3.0	1
946HC	FSC	1.00	3	227.	71.0	3.2	1
946HC	FSC	0.10	3	510.	85.0	6.0	1
946HC	FSC	0.10	3	900.	100.0	9.0	1
946HC	FSC	0.10	3	750.	100.0	7.5	1
946HC	FSC	0.10	3	949.	113.0	8.4	1
DM946	NSC	10.00	-1	12.	25.5	0.5	1
DM946	NSC	10.00	-1	15.	28.5	0.5	1
DM946	NSC	10.00	-1	15.	24.8	0.6	1
DM946	NSC	10.00	-1	24.	27.0	0.8	1
DM946	NSC	10.00	1	8.	25.0	0.3	1
DM946	NSC	10.00	1	12.	20.0	0.7	1
DM946	NSC	10.00	1	8.	24.8	0.3	1
DM946	NSC	10.00	1	11.	27.5	0.4	1
DM946	NSC	1.00	1	25.	32.5	0.8	1
DM946	NSC	1.00	1	30.	25.0	1.3	1
DM946	NSC	1.00	1	23.	26.0	0.9	1
DM946	NSC	1.00	1	20.	16.8	0.7	1
DM946	NSC	1.00	-1	42.	40.5	1.0	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
DM946	NSC	1.00	-1	45.	41.8	1.2	1
DM946	NSC	1.00	-1	27.	30.5	0.9	1
DM946	NSC	1.00	-1	37.	35.0	1.1	1
DM946	NSC	0.10	1	108.	48.0	2.3	1
DM946	NSC	0.10	1	168.	60.0	2.8	1
DM946	NSC	0.10	1	177.	68.0	2.6	1
DM946	NSC	0.10	1	180.	60.0	3.0	1
DM946	NSC	10.00	2	20.	20.0	1.0	1
DM946	NSC	10.00	2	23.	20.8	1.2	1
DM946	NSC	10.00	2	18.	20.6	0.9	1
DM946	NSC	10.00	2	23.	20.0	1.2	1
DM946	NSC	10.00	-2	17.	12.0	1.4	1
DM946	NSC	10.00	-2	13.	7.4	1.8	1
DM946	NSC	10.00	-2	15.	11.0	1.4	1
DM946	NSC	10.00	-2	17.	9.5	1.8	1
DM946	NSC	1.00	-2	39.	13.6	2.8	1
DM946	NSC	1.00	-2	33.	10.5	3.1	1
DM946	NSC	1.00	-2	38.	13.5	2.8	1
DM946	NSC	1.00	-2	23.	7.3	2.2	1
DM946	NSC	0.10	-2	163.	25.0	6.5	1
DM946	NSC	0.10	-2	195.	25.0	7.8	1
DM946	NSC	0.10	-2	320.	32.0	10.0	1
DM946	NSC	0.10	-2	374.	34.0	11.0	1
DM946	NSC	10.00	-3	19.	34.0	0.6	1
DM946	NSC	10.00	-3	66.	44.0	1.5	1
DM946	NSC	10.00	-3	56.	40.0	1.4	1
DM946	NSC	10.00	-3	71.	47.0	1.5	1
DM946	NSC	1.00	3	65.	70.0	1.3	1
DM946	NSC	1.00	3	41.	24.5	2.2	1
DM946	NSC	1.00	3	78.	71.0	1.5	1
DM946	NSC	1.00	3	60.	35.4	2.3	1
DM946	NSC	0.10	3	280.	175.0	1.6	1
DM946	NSC	0.10	3	242.	81.5	4.1	1
DM946	NSC	0.10	3	296.	185.0	1.6	1
DM946	NSC	0.10	3	261.	92.5	3.4	1
DM948	NSC	10.00	-1	18.	34.0	0.5	1
DM948	NSC	10.00	-1	25.	35.1	0.6	1
DM948	NSC	10.00	-1	13.	25.5	0.5	1
DM948	NSC	10.00	-1	24.	26.9	0.7	1
DM948	NSC	10.00	1	13.	22.0	0.6	1
DM948	NSC	10.00	1	19.	23.8	0.8	1
DM948	NSC	10.00	1	12.	25.3	0.5	1
DM948	NSC	10.00	1	17.	21.4	0.9	1
DM948	NSC	1.00	1	50.	47.4	1.1	1
DM948	NSC	1.00	1	45.	30.4	1.7	1
DM948	NSC	1.00	1	47.	36.0	1.3	1
DM948	NSC	1.00	1	38.	22.8	1.8	1
DM948	NSC	1.00	-1	38.	42.0	0.9	1
DM948	NSC	1.00	-1	49.	45.0	1.1	1
DM948	NSC	1.00	-1	37.	41.0	0.9	1
DM948	NSC	1.00	-1	49.	45.0	1.1	1
DM948	NSC	0.10	1	195.	65.0	3.0	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
DM948	NSC	0.10	1	204.	60.0	3.4	1
DM948	NSC	0.10	1	162.	58.0	2.8	1
DM948	NSC	0.10	1	204.	68.0	3.0	1
DM948	NSC	10.00	-2	18.	32.0	0.6	1
DM948	NSC	10.00	-2	16.	17.4	1.0	1
DM948	NSC	10.00	-2	17.	26.0	0.7	1
DM948	NSC	10.00	-2	18.	20.5	0.9	1
DM948	NSC	10.00	2	16.	30.0	0.5	1
DM948	NSC	10.00	2	22.	33.8	0.6	1
DM948	NSC	10.00	2	11.	24.0	0.5	1
DM948	NSC	10.00	2	21.	26.1	0.6	1
DM948	NSC	1.00	2	38.	22.8	1.7	1
DM948	NSC	1.00	2	44.	23.6	1.9	1
DM948	NSC	1.00	2	41.	24.2	1.7	1
DM948	NSC	1.00	2	51.	23.4	2.2	1
DM948	NSC	0.10	2	133.	37.0	3.6	1
DM948	NSC	0.10	2	1.2.	39.0	4.4	1
DM948	NSC	0.10	2	114.	30.0	3.8	1
DM948	NSC	0.10	2	163.	34.0	4.8	1
DM948	NSC	10.00	3	23.	44.0	0.5	1
DM948	NSC	10.00	3	35.	46.0	0.8	1
DM948	NSC	10.00	3	53.	43.4	1.3	1
DM948	NSC	10.00	3	65.	43.3	1.5	1
DM948	NSC	10.00	-3	89.	42.1	2.1	1
DM948	NSC	10.00	-3	112.	43.7	2.6	1
DM948	NSC	10.00	-3	129.	44.8	2.9	1
DM948	NSC	10.00	-3	153.	51.1	3.0	1
DM948	NSC	1.00	3	302.	88.0	3.5	1
DM948	NSC	1.00	3	351.	91.0	3.9	1
DM948	NSC	1.00	3	182.	73.0	2.7	1
DM948	NSC	1.00	3	217.	64.5	3.5	1
DM948	NSC	0.10	3	1099.	172.5	6.4	1
DM948	NSC	0.10	3	1319.	175.0	7.7	1
DM948	NSC	0.10	3	587.	163.0	3.6	1
DM948	NSC	0.10	3	540.	90.0	6.0	1
MC1488	MOT	10.00	1	16.	18.0	0.9	1
MC1488	MOT	10.00	1	26.	21.5	1.2	1
MC1488	MOT	10.00	1	16.	21.3	0.9	1
MC1488	MOT	10.00	1	32.	25.6	1.3	1
MC1488	MOT	10.00	-1	33.	36.3	1.0	1
MC1488	MOT	10.00	-1	55.	42.0	1.3	1
MC1488	MOT	10.00	-1	32.	36.3	0.9	1
MC1488	MOT	10.00	-1	54.	41.5	1.3	1
MC1488	MOT	1.00	1	28.	32.4	1.0	1
MC1488	MOT	1.00	1	60.	42.7	1.5	1
MC1488	MOT	1.00	1	27.	32.8	1.0	1
MC1488	MOT	1.00	1	44.	36.7	1.3	1
MC1488	MOT	0.10	1	192.	113.0	1.7	1
MC1488	MOT	0.10	1	276.	120.0	2.3	1
MC1488	MOT	0.10	1	187.	110.0	1.7	1
MC1488	MOT	0.10	1	265.	115.0	2.3	1
MC1488	MOT	10.00	-2	57.	135.5	0.6	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC1488	MOT	10.00	-2	135.	83.2	1.9	1
MC1488	MOT	10.00	-2	50.	160.0	0.3	1
MC1488	MOT	10.00	-2	125.	117.3	1.3	1
MC1488	MOT	10.00	2	122.	54.0	2.8	1
MC1488	MOT	10.00	2	163.	62.3	2.9	1
MC1488	MOT	10.00	2	164.	65.5	2.6	1
MC1488	MOT	10.00	2	210.	69.0	3.1	1
MC1488	MOT	1.00	2	268.	95.0	3.0	1
MC1488	MOT	1.00	2	248.	101.3	2.5	1
MC1488	MOT	1.00	2	246.	100.0	2.6	1
MC1488	MOT	1.00	2	262.	93.3	2.9	1
MC1488	MOT	0.10	2	1760.	220.0	8.0	1
MC1488	MOT	0.10	2	1870.	220.0	8.5	1
MC1488	MOT	0.10	2	1170.	195.0	6.0	1
MC1488	MOT	0.10	2	1440.	200.0	7.2	1
MC1488	MOT	1.00	-2	114.	146.0	0.9	1
MC1488	MOT	1.00	-2	173.	100.0	2.0	1
MC1488	MOT	1.00	-2	116.	173.0	0.8	1
MC1488	MOT	1.00	-2	268.	116.4	2.4	1
MC1488	MOT	0.10	-2	886.	123.0	7.2	1
MC1488	MOT	0.10	-2	1064.	140.0	7.6	1
MC1488	MOT	0.10	-2	840.	150.0	5.6	1
MC1488	MOT	0.10	-2	1085.	155.0	7.0	1
MC1489	MOT	10.00	-1	16.	12.0	1.3	1
MC1489	MOT	10.00	-1	14.	6.5	2.2	1
MC1489	MOT	10.00	-1	15.	11.0	1.4	1
MC1489	MOT	10.00	-1	19.	9.0	2.1	1
MC1489	MOT	10.00	1	10.	28.0	0.4	1
MC1489	MOT	10.00	1	8.	7.5	1.3	1
MC1489	MOT	10.00	1	9.	26.0	0.4	1
MC1489	MOT	10.00	1	10.	14.4	1.1	1
MC1489	MOT	1.00	1	23.	23.0	1.0	1
MC1489	MOT	1.00	1	36.	30.3	1.3	1
MC1489	MOT	1.00	1	23.	23.0	1.0	1
MC1489	MOT	1.00	1	27.	23.6	1.2	1
MC1489	MOT	0.10	1	134.	32.0	4.2	1
MC1489	MOT	0.10	1	171.	38.0	4.5	1
MC1489	MOT	0.10	1	126.	35.0	3.6	1
MC1489	MOT	0.10	1	180.	40.0	4.5	1
MC1489	MOT	10.00	-2	14.	30.0	0.5	1
MC1489	MOT	10.00	-2	12.	14.5	1.0	1
MC1489	MOT	10.00	-2	15.	28.5	0.5	1
MC1489	MOT	10.00	-2	14.	19.6	0.9	1
MC1489	MOT	10.00	2	9.	11.5	0.8	1
MC1489	MOT	10.00	2	13.	9.6	1.4	1
MC1489	MOT	10.00	2	10.	12.0	0.8	1
MC1489	MOT	10.00	2	13.	10.2	1.3	1
MC1489	MOT	1.00	2	33.	15.4	2.2	1
MC1489	MOT	1.00	2	47.	15.9	3.0	1
MC1489	MOT	1.00	2	37.	17.2	2.2	1
MC1489	MOT	1.00	2	74.	25.0	3.0	1
MC1489	MOT	0.10	2	729.	81.0	9.0	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC1489	MOT	0.10	2	969.	95.0	10.2	1
MC1489	MOT	0.10	2	570.	60.0	9.5	1
MC1489	MOT	0.10	2	735.	70.0	10.5	1
MC1489	MOT	10.00	1	-1.	-1.0	-1.0	1
MC1489	MOT	10.00	1	37.	58.1	0.7	1
MC1489	MOT	10.00	1	-1.	-1.0	-1.0	1
MC1489	MOT	10.00	1	37.	67.4	0.6	1
MC1489	MOT	10.00	-1	40.	86.0	0.5	1
MC1489	MOT	10.00	-1	30.	38.9	0.8	1
MC1489	MOT	10.00	-1	26.	87.5	0.3	1
MC1489	MOT	10.00	-1	47.	78.6	0.6	1
MC1489	MOT	1.00	-1	39.	98.0	0.4	1
MC1489	MOT	1.00	-1	76.	71.3	1.1	1
MC1489	MOT	1.00	-1	33.	109.0	0.3	1
MC1489	MOT	1.00	-1	58.	52.0	1.2	1
MC1489	MOT	0.10	-1	80.	160.0	0.5	1
MC1489	MOT	0.10	-1	116.	170.0	0.7	1
MC1489	MOT	0.10	-1	63.	140.0	0.5	1
MC1489	MOT	0.10	-1	87.	130.0	0.7	1
SE156	SIC	10.00	1	5.	49.5	0.1	1
SE156	SIC	10.00	1	17.	43.3	0.5	1
SE156	SIC	10.00	1	4.	50.5	0.1	1
SE156	SIC	10.00	1	21.	42.2	0.6	1
SE156	SIC	1.00	1	36.	66.0	0.6	1
SE156	SIC	1.00	1	45.	62.4	0.8	1
SE156	SIC	1.00	1	16.	66.0	0.2	1
SE156	SIC	1.00	1	47.	61.4	0.9	1
SE156	SIC	10.00	6	5.	47.5	0.1	1
SE156	SIC	10.00	6	23.	44.8	0.6	1
SE156	SIC	10.00	6	10.	59.5	0.2	1
SE156	SIC	10.00	6	29.	46.4	0.7	1
SE156	SIC	1.00	6	17.	61.6	0.3	1
SE156	SIC	1.00	6	54.	45.0	1.2	1
SE156	SIC	1.00	6	14.	68.0	0.2	1
SE156	SIC	1.00	6	48.	51.0	1.0	1
SE180J	SIC	10.00	-1	27.	21.8	1.3	1
SE180J	SIC	10.00	-1	28.	17.5	1.6	1
SE180J	SIC	10.00	-1	42.	41.4	1.0	1
SE180J	SIC	10.00	-1	58.	44.1	1.3	1
SE180J	SIC	10.00	1	41.	61.7	0.7	1
SE180J	SIC	10.00	1	65.	38.1	1.9	1
SE180J	SIC	10.00	1	-1.	-1.0	-1.0	1
SE180J	SIC	10.00	1	48.	50.9	1.3	1
SE180J	SIC	1.00	1	59.	90.0	0.7	1
SE180J	SIC	1.00	1	160.	88.0	2.1	1
SE180J	SIC	1.00	1	152.	100.9	1.6	1
SE180J	SIC	1.00	1	216.	91.2	2.5	1
SE180J	SIC	10.00	1	8.	32.0	0.3	1
SE180J	SIC	10.00	1	11.	17.2	1.1	1
SE180J	SIC	10.00	1	4.	38.5	0.1	1
SE180J	SIC	10.00	1	11.	41.2	0.3	1
SE180J	SIC	10.00	1	9.	41.0	0.2	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SE180J	SIC	10.00	1	22.	38.5	0.6	1
SE180J	SIC	0.10	1	78.	112.0	0.7	1
SE180J	SIC	0.10	1	168.	95.0	1.9	1
SE180J	SIC	10.00	-6	14.	32.1	0.5	1
SE180J	SIC	10.00	-6	13.	7.9	1.9	1
SE180J	SIC	10.00	-6	12.	18.5	1.0	1
SE180J	SIC	10.00	-6	12.	8.1	1.6	1
SE180J	SIC	10.00	6	22.	36.0	0.6	1
SE180J	SIC	10.00	6	34.	38.0	0.9	1
SE180J	SIC	10.00	6	30.	41.0	0.7	1
SE180J	SIC	10.00	6	24.	38.0	0.7	1
SE180J	SIC	1.00	6	78.	60.0	1.4	1
SE180J	SIC	1.00	6	124.	62.0	2.0	1
SE180J	SIC	1.00	6	78.	65.3	1.3	1
SE180J	SIC	1.00	6	108.	66.0	1.7	1
SE180J	SIC	0.10	6	336.	140.0	2.6	1
SE180J	SIC	0.10	6	365.	126.0	3.2	1
SE180J	SIC	0.10	6	235.	107.5	2.3	1
SE180J	SIC	0.10	6	334.	127.6	2.8	1
MC930	MOT	1.45	-1	10.	19.0	0.5	11
MC930	MOT	2.70	-1	9.	18.5	0.5	11
MC930	MOT	3.70	-1	8.	20.5	0.4	11
MC930	MOT	4.25	-1	7.	20.0	0.3	11
MC930	MOT	6.50	-1	7.	17.0	0.4	11
MC930	MOT	1.40	-1	6.	13.0	0.5	11
MC930	MOT	13.00	-1	5.	19.0	0.3	11
MC930	MOT	9.80	-1	6	18.5	0.3	11
MC930	MOT	11.60	-1	6.	16.0	0.4	11
MC930	MOT	5.00	-1	3.	11.5	0.3	11
MC930	MOT	62.00	-1	4.	18.0	0.2	11
MC930	MOT	21.00	-1	6.	18.0	0.3	11
MC930	MOT	55.00	-1	4.	14.5	0.3	11
MC930	MOT	44.00	-1	3.	11.0	0.2	11
MC930	MOT	47.00	-1	4.	17.5	0.2	11
MC930	MOT	110.00	-1	4.	16.0	0.3	11
MC930	MOT	150.00	-1	4.	14.5	0.3	11
MC930	MOT	44.00	-1	2.	11.0	0.2	11
MC930	MOT	1100.00	-1	4.	18.0	0.2	11
MC930	MOT	930.00	-1	4.	17.5	0.2	11
MC930	MOT	550.00	-1	4.	14.0	0.3	11
MC930	MOT	600.00	-1	2.	10.8	0.2	11
MC930	MOT	600.00	-1	4.	18.0	0.2	11
MC930	MOT	700.00	-1	4.	18.0	0.2	11
MC930	MOT	1000.00	-1	4.	14.5	0.2	11
MC930	MOT	400.00	-1	2.	11.0	0.2	11
MC930	MOT	1.07	-1	11.	24.0	0.4	11
MC930	MOT	1.16	-1	9.	20.0	0.5	11
MC930	MOT	0.75	-1	7.	13.0	0.5	11
MC930	MOT	0.39	-1	13.	25.0	0.5	11
MC930	MOT	0.40	-1	10.	22.0	0.5	11
MC930	MOT	0.59	-1	31.	26.0	1.2	11
MC930	MOT	0.52	-1	8.	13.0	0.6	11

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC930	MOT	0.11	-1	14.	20.5	0.7	11
MC930	MOT	0.29	-1	21.	27.0	0.8	11
MC930	MOT	0.29	-1	64.	33.0	2.0	11
MC930	MOT	0.12	-1	13.	14.5	0.9	11
MC930	MOT	0.11	-1	28.	32.5	0.8	11
MC930	MOT	0.11	-1	77.	41.0	1.9	11
MC930	MOT	0.11	-1	122.	46.0	2.6	11
MC930	MOT	0.11	-1	28.	19.0	1.5	11
MC930	MOT	0.21	-1	13.	23.5	0.6	11
MC930	MOT	0.21	-1	20.	28.0	0.7	11
MC930	MOT	1.66	-1	19.	22.0	0.9	11
MC930	MOT	0.21	-1	13.	15.0	0.9	11
MC930	MOT	11.60	-1	6.	19.1	0.3	11
MC930	MOT	12.80	-1	5.	19.0	0.3	11
MC930	MOT	10.40	-1	6.	15.0	0.4	11
MC930	MOT	3.80	-1	4.	10.8	0.3	11
MC930	MOT	0.15	-1	29.	32.0	0.9	11
MC930	MOT	0.15	-1	30.	34.0	0.9	11
MC930	MOT	0.15	-1	94.	39.0	2.4	11
MC930	MOT	0.15	-1	18.	15.6	1.2	11
RD210	RAD	0.63	-1	17.	19.0	0.9	11
RD210	RAD	0.60	-1	18.	19.0	1.0	11
RD210	RAD	0.72	-1	16.	18.0	0.9	11
RD210	RAD	2.44	-1	7.	13.0	0.6	11
RD210	RAD	1.73	-1	10.	15.4	0.6	11
RD210	RAD	0.95	-1	13.	16.5	0.8	11
RD210	RAD	6.20	-1	6.	12.7	0.5	11
RD210	RAD	7.90	-1	5.	12.5	0.4	11
RD210	RAD	3.80	-1	7.	13.0	0.5	11
RD210	RAD	19.50	-1	4.	11.4	0.3	11
RD210	RAD	16.30	-1	3.	11.0	0.3	11
RD210	RAD	17.00	-1	4.	11.5	0.3	11
RD210	RAD	4.20	-1	5.	13.5	0.4	11
RD210	RAD	800.00	-1	2.	10.8	0.2	11
RD210	RAD	120.00	-1	3.	12.3	0.3	11
RD210	RAD	670.00	-1	3.	12.4	0.2	11
RD210	RAD	640.00	-1	3.	12.0	0.2	11
RD210	RAD	85.00	-1	3.	11.9	0.3	11
RD210	RAD	195.00	-1	3.	12.1	0.2	11
RD210	RAD	840.00	-1	3.	12.6	0.2	11
RD210	RAD	0.55	-1	18.	17.0	1.1	11
RD210	RAD	0.51	-1	21.	18.0	1.1	11
RD210	RAD	0.32	-1	26.	20.0	1.3	11
RD210	RAD	0.24	-1	43.	25.0	1.7	11
RD210	RAD	0.22	-1	53.	28.0	1.9	11
RD210	RAD	0.12	-1	86.	36.0	2.4	11
RD210	RAD	0.12	-1	95.	34.0	2.8	11
MC933F	MOT	0.96	-1	9.	15.8	0.6	11
MC933F	MOT	3.10	-1	5.	12.2	0.4	11
MC933F	MOT	3.90	-1	6.	14.0	0.4	11
MC933F	MOT	9.00	-1	4.	11.0	0.4	11
MC933F	MOT	2.40	-1	5.	12.0	0.4	11

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC933F	MOT	3.50	-1	6.	13.8	0.4	11
MC933F	MOT	6.90	-1	4.	12.0	0.3	11
MC933F	MOT	25.00	-1	3.	10.9	0.3	11
MC933F	MOT	42.00	-1	2.	10.3	0.2	11
MC933F	MOT	44.00	-1	3.	11.1	0.2	11
MC933F	MOT	87.00	-1	2.	10.1	0.2	11
MC933F	MOT	57.00	-1	3.	11.0	0.2	11
MC933F	MOT	144.00	-1	2.	10.0	0.2	11
MC933F	MOT	83.00	-1	2.	10.5	0.2	11
MC933F	MOT	50.00	-1	2.	10.0	0.2	11
MC933F	MOT	320.00	-1	2.	10.7	0.2	11
MC933F	MOT	130.00	-1	2.	10.7	0.2	11
MC933F	MOT	0.32	-1	18.	16.0	1.1	11
MC933F	MOT	0.39	-1	24.	20.7	1.2	11
MC933F	MOT	0.18	-1	25.	17.0	1.5	11
MC933F	MOT	0.10	-1	30.	23.0	1.3	11
MC933F	MOT	0.10	-1	26.	17.5	1.5	11
MC933F	MOT	1.05	-1	8.	14.3	0.6	11
1053	A	0.10	2	1175.	-1.0	-1.0	9
1053	A	1.00	2	125.	-1.0	-1.0	9
1053	A	10.00	2	28.	-1.0	-1.0	9
1053	A	0.10	2	1225.	-1.0	-1.0	9
1053	A	1.00	2	165.	-1.0	-1.0	9
1053	A	10.00	2	32.	-1.0	-1.0	9
1053	B	0.10	2	98.	-1.0	-1.0	9
1053	B	0.10	2	250.	-1.0	-1.0	9
1053	B	1.00	2	43.	-1.0	-1.0	9
1053	B	1.00	2	70.	-1.0	-1.0	9
1053	B	10.00	2	20.	-1.0	-1.0	9
1053	B	10.00	2	27.	-1.0	-1.0	9
993	A	0.10	1	142.	-1.0	-1.0	9
993	A	0.10	1	109.	-1.0	-1.0	9
993	A	1.00	1	57.	-1.0	-1.0	9
993	A	1.00	1	69.	-1.0	-1.0	9
993	A	10.00	1	11.	-1.0	-1.0	9
993	A	10.00	1	15.	-1.0	-1.0	9
993	B	0.10	1	34.	-1.0	-1.0	9
993	B	0.10	1	49.	-1.0	-1.0	9
993	B	1.00	1	12.	-1.0	-1.0	9
993	B	1.00	1	14.	-1.0	-1.0	9
993	B	10.00	1	5.	-1.0	-1.0	9
993	B	10.00	1	5.	-1.0	-1.0	9
I3101	INT	0.50	1	60.	-1.0	-1.0	4
I3101	INT	0.50	1	56.	-1.0	-1.0	4
F4501	FSC	0.75	-11	7.	-1.0	-1.0	4
F4501	FSC	1.80	-11	4.	-1.0	-1.0	4
RD220	RAD	0.10	2	409.	53.5	7.6	7
RD220	RAD	0.10	2	624.	60.0	10.4	7
RD220	RAD	0.09	2	336.	70.0	4.8	7
RD220	RAD	0.10	2	607.	59.7	10.2	7
RD220	RAD	0.10	2	612.	90.0	6.8	7
RD220	RAD	0.10	2	694.	68.0	10.2	7

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
RD220	RAD	0.10	-2	495.	45.0	11.0	7
RD220	RAD	0.10	-2	495.	45.0	11.0	7
RD220	RAD	0.10	2	368.	50.0	[illegible].4	7
RD220	RAD	0.10	2	506.	51.0	9.9	7
RD220	RAD	0.10	-2	675.	67.5	10.0	7
RD220	RAD	0.10	-2	740.	72.5	10.2	7
RD220	RAD	0.10	-1	413.	137.5	3.0	7
RD220	RAD	0.10	-1	488.	113.0	4.3	7
RD220	RAD	0.09	1	90.	60.0	1.5	7
RD220	RAD	0.10	1	228.	68.0	3.4	7
RD220	RAD	0.10	2	640.	64.5	9.9	7
RD220	RAD	0.10	2	1620.	90.0	18.0	7
RD220	RAD	0.10	1	169.	64.0	2.6	7
RD220	RAD	0.10	1	240.	60.0	4.0	7
RD220	RAD	0.09	7	90.	57.3	1.6	7
RD220	RAD	0.09	7	240.	80.0	3.0	7
RD220	RAD	0.09	7	153.	73.9	2.1	7
RD220	RAD	0.09	7	210.	70.0	3.0	7
RD220	RAD	0.10	7	660.	110.0	6.0	7
RD220	RAD	0.10	7	4000.	200.0	20.0	7
RD220	RAD	0.10	7	840.	140.0	6.0	7
RD220	RAD	0.10	1	3040.	160.0	19.0	7
RD220	RAD	0.10	-7	493.	145.0	3.4	7
RD220	RAD	0.10	-7	1305.	150.0	8.[illegible]	7
RD220	RAD	0.09	-7	115.	50.0	2.3	7
RD220	RAD	0.10	-7	753.	112.0	6.7	7
RD220	RAD	0.10	-7	638.	140.0	4.6	7
RD220	RAD	0.10	-7	3240.	180.0	18.0	7
RD220	RAD	0.10	-6	260.	130.0	2.0	7
RD220	RAD	0.10	-6	432.	106.0	4.1	7
RD220	RAD	0.10	8	920.	100.0	9.2	7
RD220	RAD	0.10	8	2380.	140.0	17.0	7
RD220	RAD	0.10	8	1104.	120.0	9.2	7
RD220	RAD	0.10	8	2890.	170.0	17.0	7
RD220	RAD	0.10	-8	772.	136.0	5.7	7
RD220	RAD	0.10	-8	1153.	136.0	8.5	7
RD220	RAD	0.10	-8	908.	132.0	6.9	7
RD220	RAD	0.10	-8	1181.	138.0	8.6	7
RD220	RAD	0.09	6	242.	84.4	2.9	7
RD220	RAD	0.09	6	95.	58.9	1.6	7
RD220	RAD	0.09	6	120.	60.0	2.0	7
RD220	RAD	0.09	6	158.	68.3	2.3	7
RD220	RAD	0.09	6	196.	70.0	2.8	7
RD220	RAD	0.10	6	1960.	140.0	14.0	7
RD220	RAD	0.10	6	1960.	140.0	14.0	7
RD220	RAD	0.10	-3	1320.	110.0	12.0	7
RD220	RAD	0.10	-3	7200.	180.0	40.0	7
RD220	RAD	0.10	3	2400.	120.0	20.0	7
RD220	RAD	0.10	3	8000.	200.0	40.0	7
RD220	RAD	0.10	2	228.	30.0	7.6	7
RD220	RAD	0.10	2	500.	50.0	10.0	7
RD220	RAD	0.10	-2	1235.	65.0	19.0	7

DEVICE	MFG	TIME	PIN	PWP	VAVG	IAVG	SOD
RD220	RAD	0.10	-2	1235.	65.0	19.0	7
RD220	RAD	0.10	-2	660.	55.0	12.0	7
RD220	RAD	0.10	-2	1260.	70.0	18.0	7
RD220	RAD	0.10	-2	550.	50.0	11.0	7
RD220	RAD	0.10	-2	1044.	58.0	18.0	7
RD220	RAD	0.10	-2	609.	52.5	11.6	7
RD220	RAD	0.10	-2	944.	60.5	15.6	7
RD220	RAD	0.10	2	466.	56.0	8.3	7
RD220	RAD	0.10	2	633.	86.0	7.4	7
RD220	RAD	0.10	2	704.	73.0	9.6	7
RD220	RAD	0.10	2	534.	58.0	9.2	7
RD220	RAD	0.10	1	118.	46.0	2.6	7
RD220	RAD	0.10	1	240.	60.0	4.0	7
RD220	RAD	0.10	1	133.	50.5	2.6	7
RD220	RAD	0.10	1	74.	42.0	1.8	7
RD220	RAD	0.10	1	180.	50.0	3.6	7
RD220	RAD	0.09	1	102.	35.0	2.9	7
RD220	RAD	0.10	-1	400.	102.5	3.9	7
RD220	RAD	0.10	-1	336.	40.0	8.4	7
RD220	RAD	0.09	-1	511.	98.3	5.2	7
RD220	RAD	0.10	-1	608.	160.0	3.8	7
RD220	RAD	0.10	-1	670.	118.0	5.7	7
RD220	RAD	0.10	-1	558.	155.0	3.6	7
RD211	RAD	0.11	1	122.	18.0	6.8	7
RD211	RAD	0.15	1	358.	32.0	11.2	7
RD211	RAD	0.10	1	128.	22.0	5.8	7
RD211	RAD	0.10	1	163.	24.0	6.8	7
RD211	RAD	0.30	-1	29.	16.0	1.8	7
RD211	RAD	0.30	1	68.	20.0	3.4	7
RD211	RAD	0.30	-1	13.	13.0	1.0	7
RD211	RAD	0.30	1	76.	18.0	4.2	7
RD211	RAD	0.30	-1	17.	13.0	1.3	7
RD211	RAD	0.30	1	70.	18.0	4.2	7
RD211	RAD	0.30	1	59.	15.5	3.8	7
RD211	RAD	0.30	1	62.	14.7	4.2	7
RD211	RAD	0.30	1	51.	15.0	3.4	7
RD211	RAD	0.30	1	35.	11.5	3.0	7
RD211	RAD	0.30	1	41.	12.0	3.4	7
RD211	RAD	0.30	1	42.	14.1	3.0	7
RD211	RAD	0.30	1	41.	12.2	3.4	7
RD211	RAD	0.30	-1	11.	12.0	0.9	7
RD211	RAD	0.30	-1	18.	13.3	1.3	7
RD211	RAD	0.30	-1	9.	11.0	0.8	7
RD211	RAD	0.30	-1	17.	13.9	1.2	7
RD211	RAD	1.00	-1	6.	10.0	0.6	7
RD211	RAD	1.00	-1	12.	11.6	1.0	7
RD211	RAD	1.00	-1	6.	11.0	0.6	7
RD211	RAD	1.00	-1	7.	11.3	0.6	7
RD211	RAD	1.00	-1	6.	11.5	0.6	7
RD211	RAD	1.00	-1	7.	12.0	0.6	7
RD211	RAD	1.00	-1	6.	12.0	0.5	7
RD211	RAD	1.00	1	17.	9.5	1.8	7

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
RD211	RAD	1.00	1	23.	9.7	2.4	7
RD211	RAD	1.00	1	20.	10.5	1.9	7
RD211	RAD	1.00	1	22.	9.3	2.4	7
RD211	RAD	1.00	1	29.	12.5	2.3	7
RD211	RAD	1.00	1	35.	11.2	3.1	7
RD211	RAD	0.06	1	176.	20.0	8.8	7
RD211	RAD	0.06	1	240.	24.0	10.0	7
RD211	RAD	0.06	1	211.	22.0	9.6	7
RD211	RAD	0.06	1	291.	26.0	11.2	7
RD211	RAD	0.06	1	358.	32.0	11.2	7
RD211	RAD	0.06	1	358.	32.0	11.2	7
RD211	RAD	0.06	1	374.	36.0	10.4	7
RD211	RAD	0.06	1	374.	36.0	10.4	7
RD211	RAD	0.03	-1	90.	28.0	3.2	7
RD211	RAD	0.03	-1	128.	32.0	4.0	7
RD211	RAD	0.03	-1	90.	28.0	3.2	7
RD211	RAD	0.03	-1	120.	30.0	4.0	7
RD211	RAD	0.04	-1	73.	26.0	2.8	7
RD211	RAD	0.04	-1	67.	24.0	2.8	7
RD211B	RAD	0.13	-1	17.	15.0	1.1	7
RD211B	RAD	0.13	-1	40.	20.0	2.0	7
RD211B	RAD	0.10	-1	272.	40.0	6.8	7
RD211B	RAD	0.13	-1	499.	52.0	9.6	7
RD211B	RAD	0.10	-1	27.	17.0	1.6	7
RD211B	RAD	0.10	-1	50.	21.0	2.4	7
RD211B	RAD	0.10	1	84.	15.0	5.6	7
RD211B	RAD	0.10	1	144.	20.0	7.2	7
RD211B	RAD	0.10	1	152.	20.0	7.6	7
RD211B	RAD	0.10	1	176.	22.0	8.0	7
RD211B	RAD	0.10	1	175.	23.0	7.6	7
RD211B	RAD	0.10	1	192.	24.0	8.0	7
RD211B	RAD	0.10	1	202.	28.0	7.2	7
RD211B	RAD	0.10	1	282.	32.0	8.8	7
RD211B	RAD	0.10	1	122.	18.0	6.8	7
RD211B	RAD	0.10	1	84.	14.0	6.0	7
RD211B	RAD	0.10	1	109.	16.0	6.8	7
RD211B	RAD	0.10	1	102.	16.0	6.4	7
RD211B	RAD	0.10	1	130.	18.0	7.2	7
RD211B	RAD	0.10	1	120.	20.0	6.0	7
RD211B	RAD	0.10	1	177.	26.0	6.8	7
RD211B	RAD	0.10	-1	32.	18.0	1.8	7
RD211B	RAD	0.10	-1	62.	22.0	2.8	7
RD211B	RAD	0.10	-1	36.	20.0	1.8	7
RD211B	RAD	0.10	-1	70.	24.0	2.9	7
RD211B	RAD	0.10	-1	173.	36.0	4.8	7
RD211B	RAD	0.10	-1	65.	24.0	2.7	7
RD211B	RAD	0.10	-1	38.	18.0	2.1	7
RD211B	RAD	0.10	-1	58.	20.0	2.9	7
RD211B	RAD	0.10	-1	30.	16.0	1.9	7
RD211B	RAD	0.10	-1	60.	20.0	3.0	7
RD211B	RAD	0.10	-1	20.	14.0	1.4	7
RD211B	RAD	0.10	-1	41.	18.0	2.3	7

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
RD211B	RAD	0.10	-1	14.	14.0	1.0	7
RD211B	RAD	0.10	-1	38.	18.0	2.1	7
RD211B	RAD	0.10	1	160.	20.0	8.0	7
RD211B	RAD	0.10	1	291.	26.0	11.2	7
RD211B	RAD	0.10	1	160.	20.0	8.0	7
RD211B	RAD	0.10	1	221.	24.0	9.2	7
RD211B	RAD	0.10	1	137.	18.0	7.6	7
RD211B	RAD	0.10	1	211.	24.0	8.8	7
RD211B	RAD	0.10	1	187.	26.0	7.2	7
RD211B	RAD	0.10	1	158.	22.0	7.2	7
RD211B	RAD	0.13	1	166.	26.0	6.4	7
RD211B	RAD	0.10	1	175.	23.0	7.6	7
RD211B	RAD	0.13	1	238.	27.0	8.8	7
RD211B	RAD	0.10	1	84.	15.0	5.6	7
RD211B	RAD	0.13	1	115.	18.0	6.4	7
RD211B	RAD	0.10	1	129.	19.0	6.8	7
RD211B	RAD	0.10	1	175.	23.0	7.6	7
RD211B	RAD	0.10	1	129.	19.0	6.8	7
RD211B	RAD	0.13	1	160.	21.0	7.6	7
RD211B	RAD	0.10	1	175.	23.0	7.6	7
RD211B	RAD	0.13	1	294.	35.0	8.4	7
RD211B	RAD	0.10	-1	25.	18.0	1.4	7
RD211B	RAD	0.10	-1	55.	22.0	2.5	7
RD211B	RAD	0.10	-1	25.	18.0	1.4	7
RD211B	RAD	0.10	-1	46.	23.0	2.0	7
RD211B	RAD	0.10	-1	31.	18.0	1.7	7
RD211B	RAD	0.10	-1	53.	22.0	2.4	7
RD211B	RAD	0.10	-1	256.	40.0	6.4	7
RD211B	RAD	0.13	-1	423.	46.0	9.2	7
RD211B	RAD	0.13	-1	520.	50.0	10.4	7
RD221	RAD	0.11	2	550.	55.0	10.0	7
RD221	RAD	0.11	2	770.	55.0	14.0	7
RD221	RAD	0.11	2	813.	62.5	13.0	7
RD221	RAD	0.11	2	1255.	57.3	21.9	7
RD221	RAD	0.11	2	4122.	95.5	43.2	7
RD221	RAD	0.11	2	1285.	58.2	22.1	7
RD221	RAD	0.11	2	2154.	69.1	31.2	7
RD221	RAD	0.11	2	840.	70.0	12.0	7
RD221	RAD	0.11	2	840.	70.0	12.0	7
RD221	RAD	0.11	2	669.	49.1	13.6	7
RD221	RAD	0.11	2	1050.	75.0	14.0	7
RD221	RAD	0.11	2	2154.	69.1	31.2	7
RD221	RAD	0.11	2	880.	100.0	8.8	7
RD221	RAD	0.11	2	880.	100.0	8.8	7
RD221	RAD	0.12	2	1126.	128.0	8.8	7
RD221	RAD	0.12	2	917.	97.5	9.4	7
RD221	RAD	0.11	11	325.	65.0	5.0	7
RD221	RAD	0.11	11	544.	80.0	6.8	7
RD221	RAD	0.10	11	578.	85.0	6.8	7
RD221	RAD	0.11	11	928.	94.5	9.8	7
RD221	RAD	0.12	3	3024.	140.0	21.6	7
RD221	RAD	0.12	3	2688.	120.0	22.4	7

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
RD221	RAD	0.13	3	1400.	100.0	14.0	7
RD221	RAD	0.13	3	4000.	200.0	20.0	7
RD221	RAD	0.10	-2	1219.	67.0	18.2	7
RD221	RAD	0.13	-2	1536.	72.2	21.3	7
RD221	RAD	0.13	-2	540.	45.0	12.0	7
RD221	RAD	0.10	-2	756.	140.0	5.4	7
RD221	RAD	0.10	-2	756.	140.0	5.4	7
RD221	RAD	0.10	-2	468.	130.0	3.6	7
RD221	RAD	0.13	-2	729.	134.8	5.4	7
RD221	RAD	0.10	-2	619.	98.0	6.3	7
RD221	RAD	0.10	-2	1061.	124.0	8.6	7
RD221	RAD	0.10	-11	315.	63.0	5.0	7
RD221	RAD	0.10	-11	504.	70.0	7.2	7
RD221	RAD	0.10	-11	504.	70.0	7.2	7
RD221	RAD	0.13	-11	800.	80.0	10.0	7
RD221	RAD	0.13	-3	840.	60.0	14.0	7
RD221	RAD	0.13	-3	2500.	125.0	20.0	7
F9930	FSC	0.10	1	2750.	280.0	8.1	3
F9930	FSC	1.00	1	230.	72.0	3.2	3
F9930	FSC	10.00	1	15.	24.0	0.6	3
F9930	FSC	0.10	2	1350.	130.0	8.5	3
F9930	FSC	1.00	2	93.	40.0	2.4	3
F9930	FSC	10.00	2	16.	26.0	1.1	3
F9930	FSC	0.10	3	2100.	220.0	8.5	3
F9930	FSC	1.00	3	210.	70.0	3.0	3
F9930	FSC	10.00	3	20.	50.0	0.9	3
TI946	TIX	0.10	1	880.	200.0	4.4	3
TI946	TIX	1.00	1	15.	75.0	0.2	3
TI946	TIX	10.00	1	6.	52.0	0.1	3
TI946	TIX	0.10	2	705.	160.0	4.4	3
TI946	TIX	1.00	2	20.	40.0	0.5	3
TI946	TIX	10.00	2	14.	35.0	0.5	3
TI946	TIX	0.10	3	1100.	180.0	6.2	3
TI946	TIX	1.00	3	275.	110.0	2.5	3
TI946	TIX	10.00	3	58.	29.0	2.0	3
SE8481	SIC	0.10	1	1050.	170.0	6.2	3
SE8481	SIC	1.00	1	72.	40.0	1.8	3
SE8481	SIC	10.00	1	17.	22.0	0.8	3
SE8481	SIC	0.10	2	1120.	180.0	6.2	3
SE8481	SIC	1.00	2	47.	40.0	1.2	3
SE8481	SIC	10.00	2	38.	32.0	1.2	3
SE8481	SIC	0.24	3	3600.	330.0	11.0	3
SE8481	SIC	1.00	3	390.	130.0	3.0	3
SE8481	SIC	10.00	3	56.	75.0	0.8	3
SG140	DTL	0.10	1	2020.	270.0	7.5	3
SG140	DTL	1.00	1	54.	54.0	1.0	3
SG140	DTL	10.00	1	34.	34.0	1.0	3
SG140	DTL	0.10	2	1330.	190.0	7.0	3
SG140	DTL	1.00	2	67.	28.0	2.4	3
SG140	DTL	10.00	2	21.	21.0	1.0	3
SG140	DTL	0.14	3	3400.	310.0	11.0	3
SG140	DTL	1.00	3	210.	75.0	2.8	3

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SG140	DTL	10.00	3	84.	60.0	1.4	3
RD210	RAD	0.63	-1	17.	19.0	0.9	11
RD210	RAD	0.60	-1	18.	19.0	1.0	11
RD210	RAD	0.72	-1	16.	18.0	0.9	11
RD210	RAD	2.44	-1	7.	13.0	0.6	11
RD210	RAD	1.73	-1	10.	15.4	0.6	11
RD210	RAD	0.95	-1	13.	16.5	0.8	11
RD210	RAD	6.20	-1	6.	12.7	0.5	11
RD210	RAD	7.90	-1	5.	12.5	0.4	11
RD210	RAD	3.80	-1	7.	13.0	0.5	11
RD210	RAD	19.50	-1	4.	11.4	0.3	11
RD210	RAD	16.30	-1	3.	11.0	0.3	11
RD210	RAD	17.00	-1	4.	11.5	0.3	11
RD210	RAD	4.20	-1	5.	13.5	0.4	11
RD210	RAD	800.00	-1	2.	10.8	0.2	11
RD210	RAD	120.00	-1	3.	12.3	0.3	11
RD210	RAD	670.00	-1	3.	12.4	0.2	11
RD210	RAD	640.00	-1	3.	12.0	0.2	11
RD210	RAD	85.00	-1	3.	11.9	0.3	11
RD210	RAD	195.00	-1	3.	12.1	0.2	11
RD210	RAD	840.00	-1	3.	12.6	0.2	11
RD210	RAD	0.55	-1	18.	17.0	1.1	11
RD210	RAD	0.51	-1	21.	18.0	1.1	11
RD210	RAD	0.32	-1	26.	20.0	1.3	11
RD210	RAD	0.24	-1	43.	25.0	1.7	11
RD210	RAD	0.22	-1	53.	28.0	1.9	11
RD210	RAD	0.12	-1	86.	36.0	2.4	11
RD210	RAD	0.12	-1	95.	34.0	2.8	11
MC4043	MOT	10.00	-1	14.	8.2	1.8	1
MC4043	MOT	10.00	-1	31.	23.6	1.7	1
MC4043	MOT	10.00	-1	15.	8.1	2.0	1
MC4043	MOT	10.00	-1	32.	19.8	1.9	1
MC4043	MOT	10.00	1	11.	21.0	0.5	1
MC4043	MOT	10.00	1	13.	20.0	0.7	1
MC4043	MOT	10.00	1	9.	20.0	0.4	1
MC4043	MOT	10.00	1	22.	22.0	1.0	1
MC4043	MOT	1.00	1	36.	28.0	1.3	1
MC4043	MOT	1.00	1	101.	44.0	2.3	1
MC4043	MOT	1.00	1	40.	31.0	1.3	1
MC4043	MOT	1.00	1	99.	43.0	2.3	1
MC4043	MOT	0.10	1	329.	73.0	4.5	1
MC4043	MOT	0.10	1	632.	85.8	7.6	1
MC4043	MOT	0.10	1	321.	73.0	4.4	1
MC4043	MOT	0.10	1	656.	84.5	7.8	1
MC4043	MOT	10.00	2	424.	16.3	26.0	1
MC4043	MOT	10.00	2	689.	25.0	27.8	1
MC4043	MOT	10.00	2	450.	20.0	22.5	1
MC4043	MOT	10.00	2	681.	28.6	23.9	1
MC4043	MOT	10.00	-2	179.	13.8	13.0	1
MC4043	MOT	10.00	-2	209.	13.9	15.0	1
MC4043	MOT	10.00	-2	176.	13.5	13.0	1
MC4043	MOT	10.00	-2	203.	13.9	14.6	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC4043	MOT	1.00	-2	515.	19.6	26.3	1
MC4043	MOT	1.00	-2	660.	22.0	30.0	1
MC4043	MOT	1.00	-2	517.	19.5	26.5	1
MC4043	MOT	1.00	-2	615.	20.5	30.0	1
MC4043	MOT	0.10	-2	2182.	62.0	28.4	1
MC4043	MOT	0.10	-2	3141.	76.0	33.6	1
7400DC	FSC	0.10	1	120.	38.8	2.3	1
7400DC	FSC	0.10	1	162.	39.3	3.6	1
7400DC	FSC	10.00	-2	70.	19.5	3.6	1
7400DC	FSC	10.00	-2	168.	36.8	4.6	1
7400DC	FSC	1.00	2	61.	38.0	1.6	1
7400DC	FSC	1.00	2	55.	21.8	2.7	1
7400DC	FSC	10.00	2	20.	21.7	0.9	1
7400DC	FSC	10.00	2	22.	21.2	1.1	1
7400DC	FSC	10.00	2	17.	20.4	0.8	1
7400DC	FSC	10.00	2	20.	19.6	1.1	1
7400DC	FSC	1.00	2	55.	18.3	3.0	1
7400DC	FSC	1.00	2	89.	24.0	3.7	1
7400DC	FSC	10.00	-1	7.	6.9	1.0	1
7400DC	FSC	10.00	-1	8.	6.6	1.3	1
7400DC	FSC	10.00	-1	9.	8.1	1.2	1
7400DC	FSC	10.00	-1	12.	9.3	1.3	1
7400DC	FSC	10.00	1	4.	5.6	0.7	1
7400DC	FSC	10.00	1	5.	5.2	0.9	1
7400DC	FSC	10.00	1	8.	15.2	0.5	1
7400DC	FSC	10.00	1	3.	5.2	0.7	1
7400DC	FSC	1.00	1	15.	13.8	1.1	1
7400DC	FSC	1.00	1	26.	17.3	1.6	1
7400DC	FSC	1.00	1	23.	17.8	1.3	1
7400DC	FSC	1.00	1	29.	18.8	1.6	1
7400DC	FSC	0.10	1	161.	37.7	3.7	1
7400DC	FSC	0.10	1	215.	43.7	4.3	1
7400DC	FSC	10.00	-2	30.	13.5	2.3	1
7400DC	FSC	10.00	-2	48.	17.2	2.8	1
7400DC	FSC	10.00	-2	47.	17.3	2.7	1
7400DC	FSC	10.00	-2	62.	18.2	3.4	1
MC7400L	MOT	10.00	-1	20.	22.4	0.9	1
MC7400L	MOT	10.00	-1	25.	22.4	1.1	1
MC7400L	MOT	10.00	-1	65.	43.0	1.5	1
MC7400L	MOT	10.00	-1	60.	37.7	1.6	1
MC7400L	MOT	10.00	1	2.	16.0	0.2	1
MC7400L	MOT	10.00	1	8.	21.3	0.4	1
MC7400L	MOT	10.00	1	3.	17.2	0.2	1
MC7400L	MOT	10.00	1	7.	21.2	0.3	1
MC7400L	MOT	1.00	1	18.	28.0	0.7	1
MC7400L	MOT	1.00	1	27.	30.0	0.9	1
MC7400L	MOT	1.00	1	17.	27.3	0.6	1
MC7400L	MOT	1.00	1	25.	28.0	0.9	1
MC7400L	MOT	0.10	1	84.	53.7	1.4	1
MC7400L	MOT	0.10	1	171.	60.5	2.5	1
MC7400L	MOT	0.10	1	121.	54.4	2.0	1
MC7400L	MOT	0.10	1	191.	67.9	2.5	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC7400L	MOT	1.00	-2	34.	14.0	2.4	1
MC7400L	MOT	1.00	-2	37.	13.0	2.8	1
MC7400L	MOT	10.00	-2	41.	14.8	2.8	1
MC7400L	MOT	10.00	-2	45.	13.1	3.4	1
MC7400L	MOT	10.00	-2	14.	11.0	1.3	1
MC7400L	MOT	10.00	-2	15.	7.4	2.0	1
MC7400L	MOT	10.00	-2	15.	11.0	1.4	1
MC7400L	MOT	10.00	-2	15.	7.8	2.0	1
MC7400L	MOT	10.00	2	18.	22.5	0.8	1
MC7400L	MOT	10.00	2	11.	11.0	1.2	1
MC7400L	MOT	10.00	2	9.	18.0	0.5	1
MC7400L	MOT	10.00	2	18.	18.4	1.0	1
SN7490	TIX	10.00	2	16.	10.0	1.7	1
SN7490	TIX	10.00	2	13.	6.0	2.1	1
SN7490	TIX	10.00	2	17.	13.8	1.2	1
SN7490	TIX	10.00	2	18.	11.4	1.6	1
SN7490	TIX	10.00	2	20.	12.6	1.6	1
SN7490	TIX	10.00	-2	13.	5.6	2.0	1
SN7490	TIX	10.00	-2	15.	11.3	1.4	1
SN7490	TIX	10.00	-2	17.	10.2	1.6	1
SN7490	TIX	1.00	-2	54.	17.3	3.1	1
SN7490	TIX	1.00	-2	59.	16.2	3.6	1
SN7490	TIX	1.00	-2	105.	27.5	3.8	1
SN7490	TIX	1.00	-2	83.	17.3	4.8	1
SN7490	TIX	10.00	3	84.	29.0	2.9	1
SN7490	TIX	10.00	3	103.	29.9	3.5	1
SN7490	TIX	10.00	-3	51.	16.5	3.1	1
SN7490	TIX	10.00	-3	69.	21.7	3.3	1
SN7490	TIX	10.00	-3	40.	13.3	3.0	1
SN7490	TIX	10.00	-3	62.	19.5	3.2	1
SN7490	TIX	1.00	-3	245.	35.0	7.0	1
SN7490	TIX	1.00	-3	407.	53.5	7.6	1
SN7490	TIX	1.00	-3	217.	32.5	6.7	1
SN7490	TIX	1.00	-3	410.	38.0	10.8	1
SN7490	TIX	10.00	-1	14.	11.0	1.3	1
SN7490	TIX	10.00	-1	19.	12.5	1.6	1
SN7490	TIX	10.00	-1	15.	12.2	1.2	1
SN7490	TIX	10.00	-1	27.	16.0	1.7	1
SN7490	TIX	10.00	1	6.	17.3	0.3	1
SN7490	TIX	10.00	1	9.	18.2	0.5	1
SN7490	TIX	10.00	1	6.	17.2	0.4	1
SN7490	TIX	10.00	1	7.	14.9	0.5	1
SN7490	TIX	1.00	1	22.	19.0	1.2	1
SN7490	TIX	1.00	1	33.	20.9	1.6	1
SN7490	TIX	1.00	1	48.	28.0	1.7	1
SN7490	TIX	1.00	1	55.	25.0	2.2	1
SN7490	TIX	0.09	1	285.	54.9	4.2	1
SN7490	TIX	0.09	1	356.	58.9	4.5	1
SN7490	TIX	0.09	1	284.	53.6	4.3	1
SN7490	TIX	0.09	1	374.	62.6	4.9	1
SN74163	TIX	10.00	-1	28.	27.0	1.0	1
SN74163	TIX	10.00	-1	39.	30.0	1.3	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74163	TIX	10.00	-1	25.	23.0	1.1	1
SN74163	TIX	10.00	-1	35.	26.0	1.3	1
SN74163	TIX	10.00	1	8.	18.0	0.4	1
SN74163	TIX	10.00	1	9.	18.6	0.5	1
SN74163	TIX	10.00	1	8.	16.1	0.5	1
SN74163	TIX	10.00	1	9.	17.7	0.5	1
SN74163	TIX	1.00	1	16.	21.0	0.8	1
SN74163	TIX	1.00	1	21.	23.4	0.9	1
SN74163	TIX	1.00	1	16.	21.8	0.7	1
SN74163	TIX	1.00	1	22.	24.0	0.9	1
SN74163	TIX	0.10	1	162.	60.0	2.7	1
SN74163	TIX	0.10	1	216.	72.0	3.0	1
SN74163	TIX	0.10	1	157.	54.0	2.9	1
SN74163	TIX	0.10	1	195.	61.0	3.2	1
SN74163	TIX	10.00	12	5.	14.0	0.4	1
SN74163	TIX	10.00	12	6.	14.4	0.4	1
SN74163	TIX	10.00	12	3.	12.0	0.3	1
SN74163	TIX	10.00	12	5.	12.1	0.4	1
SN74163	TIX	10.00	-12	17.	16.0	1.1	1
SN74163	TIX	10.00	-12	26.	18.8	1.4	1
SN74163	TIX	10.00	-12	16.	14.5	1.1	1
SN74163	TIX	10.00	-12	21.	16.5	1.3	1
SN74163	TIX	1.00	12	14.	16.3	0.9	1
SN74163	TIX	1.00	12	18.	18.8	0.9	1
SN74163	TIX	1.00	12	16.	19.4	0.8	1
SN74163	TIX	1.00	12	21.	20.0	1.0	1
SN74163	TIX	0.10	12	112.	40.0	2.8	1
SN74163	TIX	0.10	12	132.	44.0	3.0	1
SN74163	TIX	0.10	12	112.	40.0	2.8	1
SN74163	TIX	0.10	12	150.	47.0	3.2	1
SN74163	TIX	10.00	-13	10.	13.0	0.6	1
SN74163	TIX	10.00	-13	13.	14.0	0.9	1
SN74163	TIX	10.00	-13	10.	13.0	0.8	1
SN74163	TIX	10.00	-13	13.	14.0	1.0	1
SN74163	TIX	10.00	13	7.	18.0	0.4	1
SN74163	TIX	10.00	13	9.	18.4	0.5	1
SN74163	TIX	10.00	13	7.	16.5	0.4	1
SN74163	TIX	10.00	13	8.	17.1	0.5	1
SN74163	TIX	1.00	13	16.	24.0	0.7	1
SN74163	TIX	1.00	13	19.	21.3	0.9	1
SN74163	TIX	1.00	13	21.	27.0	0.8	1
SN74163	TIX	0.10	13	192.	60.0	3.2	1
SN74163	TIX	0.10	13	252.	70.0	3.6	1
SN74163	TIX	0.10	13	180.	60.0	3.0	1
SN74163	TIX	0.10	13	241.	65.0	3.7	1
SN74163	TIX	10.00	2	27.	19.8	1.4	1
SN74163	TIX	10.00	2	23.	14.8	1.6	1
SN74163	TIX	10.00	2	26.	19.6	1.3	1
SN74163	TIX	10.00	2	26.	16.7	1.6	1
SN74163	TIX	10.00	-2	39.	14.0	2.8	1
SN74163	TIX	10.00	-2	29.	9.4	3.1	1
SN74163	TIX	10.00	-2	57.	15.0	3.8	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74163	TIX	10.00	-2	68.	16.5	4.1	1
SN74163	TIX	1.00	2	82.	34.0	2.4	1
SN74163	TIX	1.00	2	45.	14.4	3.3	1
SN74163	TIX	1.00	2	102.	33.0	3.1	1
SN74163	TIX	1.00	2	65.	14.8	4.4	1
SN74163	TIX	0.10	2	240.	40.0	6.0	1
SN74163	TIX	0.10	2	330.	50.0	6.6	1
SN74163	TIX	0.10	2	211.	37.0	5.7	1
SN74163	TIX	0.10	2	276.	40.0	6.9	1
MC4006	MOT	0.10	1	52.	41.6	1.0	1
MC4006	MOT	0.10	1	74.	45.6	1.3	1
MC4006	MOT	10.00	2	13.	17.2	0.8	1
MC4006	MOT	10.00	2	21.	16.1	1.4	1
MC4006	MOT	10.00	2	13.	18.6	0.7	1
MC4006	MOT	10.00	2	20.	17.3	1.2	1
MC4006	MOT	10.00	-2	22.	12.0	1.8	1
MC4006	MOT	10.00	-2	44.	22.0	2.0	1
MC4006	MOT	10.00	-2	20.	12.0	1.7	1
MC4006	MOT	10.00	-2	24.	12.7	1.9	1
MC4006	MOT	1.00	2	122.	32.0	3.8	1
MC4006	MOT	1.00	2	160.	30.0	5.4	1
MC4006	MOT	1.00	2	228.	40.0	5.7	1
MC4006	MOT	1.00	2	331.	55.2	6.0	1
MC4006	MOT	10.00	1	5.	18.0	0.3	1
MC4006	MOT	10.00	1	7.	21.0	0.3	1
MC4006	MOT	10.00	1	5.	17.8	0.3	1
MC4006	MOT	10.00	1	7.	20.4	0.4	1
MC4006	MOT	10.00	-1	20.	11.5	1.7	1
MC4006	MOT	10.00	-1	30.	16.0	1.9	1
MC4006	MOT	10.00	-1	19.	11.0	1.7	1
MC4006	MOT	10.00	-1	29.	14.0	2.1	1
MC4006	MOT	1.00	1	20.	28.0	0.7	1
MC4006	MOT	1.00	1	32.	40.0	0.8	1
MC4006	MOT	1.00	1	19.	32.0	0.6	1
MC4006	MOT	1.00	1	32.	40.0	0.8	1
MC4006	MOT	0.10	1	92.	43.2	1.7	1
MC4006	MOT	0.10	1	132.	47.2	2.2	1
MC4006	MOT	0.10	2	816.	78.0	8.4	1
MC4006	MOT	0.10	2	875.	76.0	9.4	1
MC4006	MOT	0.10	2	867.	80.0	8.8	1
MC4006	MOT	0.10	2	983.	82.0	9.8	1
SN7400	TIX	10.00	1	7.	26.8	0.3	1
SN7400	TIX	10.00	1	10.	31.5	0.3	1
SN7400	TIX	10.00	1	6.	20.9	0.3	1
SN7400	TIX	10.00	1	11.	26.3	0.4	1
SN7400	TIX	1.00	1	37.	45.0	0.8	1
SN7400	TIX	1.00	1	56.	42.0	1.4	1
SN7400	TIX	1.00	1	29.	36.0	0.8	1
SN7400	TIX	1.00	1	40.	43.3	0.9	1
SN7400	TIX	10.00	2	23.	16.2	1.5	1
SN7400	TIX	10.00	2	24.	14.0	1.8	1
SN7400	TIX	10.00	-2	19.	17.7	1.1	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN7400	TIX	10.00	-2	24.	17.0	1.5	1
SN7400	TIX	10.00	-2	20.	12.0	1.7	1
SN7400	TIX	10.00	-2	23.	10.5	2.2	1
SN7400	TIX	10.00	-2	22.	13.0	1.7	1
SN7400	TIX	10.00	-2	25.	11.9	2.2	1
SN7400	TIX	1.00	-2	85.	25.0	3.4	1
SN7400	TIX	1.00	-2	126.	30.0	4.2	1
SN7400	TIX	1.00	-2	126.	30.0	4.2	1
SN7400	TIX	1.00	-2	138.	29.8	4.7	1
SN7402	TIX	10.00	-1	73.	20.0	3.7	1
SN7402	TIX	10.00	-1	79.	19.9	4.0	1
SN7402	TIX	10.00	-1	76.	22.0	3.5	1
SN7402	TIX	10.00	-1	86.	21.8	4.0	1
SN7402	TIX	10.00	1	6.	23.0	0.2	1
SN7402	TIX	10.00	1	12.	31.0	0.4	1
SN7402	TIX	10.00	1	6.	23.0	0.2	1
SN7402	TIX	10.00	1	12.	31.5	0.4	1
SN7402	TIX	1.00	1	38.	64.0	0.6	1
SN7402	TIX	1.00	1	55.	52.0	1.2	1
SN7402	TIX	1.00	1	30.	38.0	0.8	1
SN7402	TIX	1.00	1	44.	45.0	1.0	1
SN7402	TIX	10.00	-2	91.	32.0	2.9	1
SN7402	TIX	10.00	-2	110.	34.1	3.3	1
SN7402	TIX	10.00	-2	78.	27.0	2.9	1
SN7402	TIX	10.00	-2	79.	24.4	3.3	1
SN7402	TIX	10.00	2	19.	16.8	1.1	1
SN7402	TIX	10.00	2	22.	15.6	1.5	1
SN7402	TIX	10.00	2	20.	17.1	1.2	1
SN7402	TIX	10.00	2	23.	15.4	1.6	1
SN7402	TIX	1.00	2	43.	24.0	1.8	1
SN7402	TIX	1.00	2	77.	27.4	2.9	1
SN7402	TIX	1.00	2	52.	26.0	2.0	1
SN7402	TIX	1.00	2	78.	30.5	2.6	1
SN7413	TIX	10.00	-1	108.	33.5	3.3	1
SN7413	TIX	10.00	-1	182.	63.0	3.0	1
SN7413	TIX	10.00	-1	102.	31.5	3.3	1
SN7413	TIX	10.00	-1	149.	54.0	3.0	1
SN7413	TIX	10.00	1	10.	34.0	0.3	1
SN7413	TIX	10.00	1	22.	21.9	1.0	1
SN7413	TIX	10.00	1	31.	51.0	0.6	1
SN7413	TIX	10.00	1	38.	40.5	1.0	1
SN7413	TIX	1.00	1	77.	39.0	2.0	1
SN7413	TIX	1.00	1	101.	43.2	2.3	1
SN7413	TIX	1.00	1	118.	48.8	2.4	1
SN7413	TIX	1.00	1	118.	41.5	2.8	1
SN7413	TIX	0.10	1	285.	95.0	3.0	1
SN7413	TIX	0.10	1	352.	95.0	3.7	1
SN7413	TIX	0.10	1	256.	80.0	3.2	1
SN7413	TIX	0.10	1	351.	90.0	3.9	1
SN7413	TIX	10.00	-2	35.	14.0	2.5	1
SN7413	TIX	10.00	-2	39.	14.5	2.7	1
SN7413	TIX	10.00	-2	35.	14.0	2.5	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN7413	TIX	10.00	-2	40.	14.5	2.8	1
SN7413	TIX	10.00	2	38.	23.6	1.6	1
SN7413	TIX	10.00	2	37.	21.5	1.8	1
SN7413	TIX	10.00	2	33.	21.4	1.6	1
SN7413	TIX	10.00	2	32.	17.6	2.0	1
SN7413	TIX	1.00	2	116.	38.5	3.0	1
SN7413	TIX	1.00	2	133.	33.0	4.0	1
SN7413	TIX	1.00	2	117.	41.3	2.8	1
SN7413	TIX	1.00	2	159.	40.5	3.9	1
N7400F	SIG	10.00	-1	21.	19.2	1.1	1
N7400F	SIG	10.00	-1	30.	21.7	1.4	1
N7400F	SIG	10.00	-1	23.	18.8	1.2	1
N7400F	SIG	10.00	-1	27.	19.5	1.4	1
N7400F	SIG	10.00	1	11.	21.8	0.5	1
N7400F	SIG	10.00	1	14.	20.1	0.7	1
N7400F	SIG	10.00	1	19.	23.3	0.8	1
N7400F	SIG	10.00	1	23.	24.8	0.9	1
N7400F	SIG	1.00	1	101.	48.0	2.1	1
N7400F	SIG	1.00	1	123.	49.0	2.5	1
N7400F	SIG	1.00	1	90.	43.0	2.1	1
N7400F	SIG	1.00	1	117.	45.0	2.6	1
N7400F	SIG	0.10	1	819.	111.6	6.7	1
N7400F	SIG	0.10	1	1051.	113.5	8.6	1
N7400F	SIG	1.00	-2	59.	17.5	3.3	1
N7400F	SIG	1.00	-2	67.	15.9	4.2	1
N7400F	SIG	0.10	1	865.	91.4	8.3	1
N7400F	SIG	0.10	1	1009.	94.0	9.4	1
N7400F	SIG	10.00	2	18.	18.8	1.0	1
N7400F	SIG	10.00	2	23.	16.6	1.4	1
N7400F	SIG	10.00	2	98.	21.6	5.3	1
N7400F	SIG	10.00	2	24.	20.1	1.3	1
N7400F	SIG	10.00	-2	20.	12.1	1.6	1
N7400F	SIG	10.00	-2	54.	26.0	2.1	1
N7400F	SIG	10.00	-2	12.	9.5	1.3	1
N7400F	SIG	10.00	-2	25.	13.1	2.0	1
N7400F	SIG	1.00	-2	87.	22.5	3.9	1
N7400F	SIG	1.00	-2	112.	30.4	3.7	1
N7400F	SIG	1.00	-2	47.	21.0	2.3	1
N7400F	SIG	1.00	-2	43.	19.2	2.3	1
SN74H60	TIX	10.00	-1	4.	8.8	0.5	1
SN74H60	TIX	10.00	-1	4.	6.6	0.6	1
SN74H60	TIX	10.00	-1	3.	10.7	0.3	1
SN74H60	TIX	10.00	-1	3.	6.8	0.5	1
SN74H60	TIX	10.00	1	1.	2.7	0.4	1
SN74H60	TIX	10.00	1	3.	7.1	0.4	1
SN74H60	TIX	10.00	1	2.	10.5	0.2	1
SN74H60	TIX	10.00	1	3.	7.0	0.4	1
SN74H60	TIX	1.00	1	7.	9.2	0.8	1
SN74H60	TIX	1.00	1	8.	9.8	0.8	1
SN74H60	TIX	1.00	1	6.	10.4	0.5	1
SN74H60	TIX	1.00	1	8.	10.8	0.7	1
SN74H60	TIX	0.10	1	106.	46.0	2.4	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74H60	TIX	0.10	1	148.	51.0	3.0	1
SN74H60	TIX	0.10	1	87.	39.0	2.3	1
SN74H60	TIX	0.10	1	126.	49.0	2.6	1
SN74H60	TIX	10.00	1	3.	6.2	0.4	1
SN74H60	TIX	10.00	1	4.	8.2	0.4	1
SN74H60	TIX	3.00	1	4.	7.8	0.5	1
SN74H60	TIX	3.00	1	4.	7.6	0.5	1
SN74H60	TIX	0.30	1	28.	17.5	1.6	1
SN74H60	TIX	0.30	1	34.	20.0	1.7	1
SN74H60	TIX	10.00	-1	7.	11.4	0.6	1
SN74H60	TIX	10.00	-1	6.	7.9	0.8	1
SN74H00	TIX	10.00	-1	68.	42.1	1.6	1
SN74H00	TIX	10.00	-1	65.	29.5	2.4	1
SN74H00	TIX	10.00	-1	67.	44.7	1.5	1
SN74H00	TIX	10.00	-1	51.	22.1	2.5	1
SN74H00	TIX	10.00	1	3.	16.0	0.2	1
SN74H00	TIX	10.00	1	8.	20.5	0.4	1
SN74H00	TIX	10.00	1	7.	19.6	0.3	1
SN74H00	TIX	10.00	1	7.	19.6	0.4	1
SN74H00	TIX	1.00	1	14.	27.0	0.5	1
SN74H00	TIX	1.00	1	21.	34.0	0.6	1
SN74H00	TIX	1.00	1	13.	28.0	0.5	1
SN74H00	TIX	1.00	1	20.	32.0	0.6	1
SN74H00	TIX	10.00	2	25.	17.5	1.4	1
SN74H00	TIX	10.00	2	28.	15.8	1.8	1
SN74H00	TIX	10.00	2	26.	20.6	1.3	1
SN74H00	TIX	10.00	2	32.	20.0	1.6	1
SN74H00	TIX	10.00	-2	11.	10.0	1.1	1
SN74H00	TIX	10.00	-2	17.	11.4	1.5	1
SN74H00	TIX	10.00	-2	11.	10.0	1.1	1
SN74H00	TIX	10.00	-2	15.	9.8	1.6	1
SN74H00	TIX	1.00	-2	46.	16.0	2.9	1
SN74H00	TIX	1.00	-2	59.	18.0	3.3	1
SN74H00	TIX	1.00	-2	51.	16.0	3.2	1
SN74H00	TIX	1.00	-2	58.	16.6	3.5	1
SN74H05	TIX	10.00	1	6.	16.0	0.4	1
SN74H05	TIX	10.00	1	7.	12.2	0.6	1
SN74H05	TIX	10.00	1	6.	16.0	0.4	1
SN74H05	TIX	10.00	1	7.	12.1	0.6	1
SN74H05	TIX	10.00	1	9.	17.0	0.5	1
SN74H05	TIX	10.00	1	8.	10.8	0.8	1
SN74H05	TIX	10.00	1	7.	16.0	0.5	1
SN74H05	TIX	10.00	1	9.	15.8	0.6	1
SN74H05	TIX	10.00	1	9.	17.0	0.6	1
SN74H05	TIX	10.00	1	10.	16.2	0.6	1
SN74H05	TIX	10.00	1	8.	16.0	0.5	1
SN74H05	TIX	10.00	1	10.	17.6	0.6	1
SN74H05	TIX	10.00	1	6.	16.0	0.4	1
SN74H05	TIX	10.00	1	8.	15.3	0.5	1
SN74H05	TIX	10.00	1	6.	16.0	0.4	1
SN74H05	TIX	10.00	1	8.	15.9	0.5	1
SN74H05	TIX	1.00	1	27.	23.5	1.2	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74H05	TIX	1.00	1	18.	9.9	1.9	1
SN74H05	TIX	1.00	1	24.	20.4	1.2	1
SN74H05	TIX	1.00	1	30.	15.1	2.0	1
SN74H05	TIX	1.00	1	29.	18.8	1.6	1
SN74H05	TIX	1.00	1	43.	21.5	2.0	1
SN74H05	TIX	1.00	1	25.	18.0	1.4	1
SN74H05	TIX	1.00	1	32.	20.0	1.6	1
SN74H05	TIX	1.00	1	12.	15.0	0.8	1
SN74H05	TIX	1.00	1	32.	18.0	1.8	1
SN74L00	TIX	10.00	1	6.	28.1	0.2	1
SN74L00	TIX	10.00	1	18.	24.0	0.8	1
SN74L00	TIX	10.00	1	7.	30.0	0.2	1
SN74L00	TIX	10.00	1	16.	21.8	0.8	1
SN74L00	TIX	10.00	-1	34.	38.0	0.9	1
SN74L00	TIX	10.00	-1	26.	20.2	1.7	1
SN74L00	TIX	10.00	-1	25.	35.0	0.7	1
SN74L00	TIX	10.00	-1	19.	15.3	1.7	1
SN74L00	TIX	1.00	1	39.	45.6	0.9	1
SN74L00	TIX	1.00	1	51.	32.8	1.6	1
SN74L00	TIX	1.00	1	37.	39.6	1.0	1
SN74L00	TIX	1.00	1	54.	38.0	1.5	1
SN74L00	TIX	10.00	-7	9.	38.0	0.2	1
SN74L00	TIX	10.00	-7	28.	25.9	1.1	1
SN74L00	TIX	10.00	-7	32.	44.1	0.7	1
SN74L00	TIX	10.00	-7	43.	39.5	1.1	1
SN74L00	TIX	10.00	-7	8.	38.0	0.2	1
SN74L00	TIX	10.00	-7	23.	42.9	0.6	1
SN74L00	TIX	10.00	7	9.	29.0	0.3	1
SN74L00	TIX	10.00	7	14.	23.8	0.7	1
SN74L00	TIX	10.00	7	4.	30.0	0.1	1
SN74L00	TIX	10.00	7	10.	29.5	0.4	1
SN74L00	TIX	1.00	-7	27.	45.0	0.6	1
SN74L00	TIX	1.00	-7	37.	46.0	0.8	1
SN74L00	TIX	1.00	-7	27.	45.0	0.6	1
SN74L00	TIX	1.00	-7	36.	45.0	0.8	1
SN74L71	TIX	10.00	11	12.	24.0	0.5	1
SN74L71	TIX	10.00	11	19.	23.6	0.8	1
SN74L71	TIX	10.00	11	9.	23.0	0.4	1
SN74L71	TIX	10.00	11	17.	19.5	1.0	1
SN74L71	TIX	10.00	-11	5.	14.0	0.4	1
SN74L71	TIX	10.00	-11	9.	16.0	0.6	1
SN74L71	TIX	10.00	-11	4.	13.0	0.3	1
SN74L71	TIX	10.00	-11	9.	17.2	0.5	1
SN74L71	TIX	10.00	-1	9.	26.0	0.4	1
SN74L71	TIX	10.00	-1	34.	30.0	1.2	1
SN74L71	TIX	10.00	-1	9.	25.0	0.4	1
SN74L71	TIX	10.00	-1	27.	33.0	0.8	1
SN74L71	TIX	10.00	-1	-1.	-1.0	-1.0	1
SN74L71	TIX	10.00	-1	45.	30.0	1.5	1
SN74L71	TIX	10.00	-1	-1.	-1.0	-1.0	1
SN74L71	TIX	10.00	-1	45.	32.0	1.4	1
SN74L71	TIX	10.00	1	9.	23.0	0.4	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74L71	TIX	10.00	1	35.	29.2	1.3	1
SN74L71	TIX	10.00	1	9.	24.0	0.4	1
SN74L71	TIX	10.00	1	21.	23.1	1.0	1
SN74L71	TIX	1.00	1	32.	35.0	0.9	1
SN74L71	TIX	1.00	1	63.	42.0	1.5	1
SN74L71	TIX	1.00	1	32.	35.0	0.9	1
SN74L71	TIX	1.00	1	67.	42.0	1.6	1
SN74L73	TIX	10.00	11	9.	18.0	0.5	1
SN74L73	TIX	10.00	11	14.	17.6	0.8	1
SN74L73	TIX	10.00	11	8.	19.0	0.4	1
SN74L73	TIX	10.00	11	11.	19.0	0.6	1
SN74L73	TIX	1.00	11	36.	30.0	1.2	1
SN74L73	TIX	1.00	11	48.	34.0	1.4	1
SN74L73	TIX	1.00	11	39.	30.0	1.3	1
SN74L73	TIX	1.00	11	56.	33.0	1.7	1
SN74L73	TIX	10.00	-3	346.	54.0	6.4	1
SN74L73	TIX	10.00	-3	371.	54.6	6.8	1
SN74L73	TIX	10.00	-3	167.	38.0	4.4	1
SN74L73	TIX	10.00	-3	204.	40.0	5.1	1
SN74L73	TIX	10.00	-3	162.	36.0	4.5	1
SN74L73	TIX	10.00	-3	162.	30.8	5.3	1
SN74L73	TIX	1.00	-3	396.	72.0	5.5	1
SN74L73	TIX	1.00	-3	488.	80.0	6.1	1
SN74L73	TIX	1.00	-3	475.	72.0	6.6	1
SN74L73	TIX	1.00	-3	530.	78.0	6.8	1
SN74L73	TIX	10.00	12	1.	11.0	0.1	1
SN74L73	TIX	10.00	12	5.	9.5	0.5	1
SN74L73	TIX	10.00	12	3.	6.4	0.6	1
SN74L73	TIX	10.00	12	5.	5.4	0.9	1
SN74L73	TIX	1.00	12	8.	10.6	0.7	1
SN74L73	TIX	1.00	12	13.	11.4	1.2	1
SN74L73	TIX	1.00	12	8.	11.6	0.7	1
SN74L73	TIX	1.00	12	15.	13.0	1.2	1
SN74L95	TIX	10.00	1	15.	31.0	0.5	1
SN74L95	TIX	10.00	1	25.	35.1	0.7	1
SN74L95	TIX	10.00	1	17.	28.0	0.6	1
SN74L95	TIX	10.00	1	16.	28.3	0.6	1
SN74L95	TIX	1.00	1	32.	43.0	0.8	1
SN74L95	TIX	1.00	1	45.	33.0	1.5	1
SN74L95	TIX	1.00	1	21.	30.0	0.7	1
SN74L95	TIX	1.00	1	44.	28.5	1.6	1
SN74L95	TIX	10.00	15	7.	28.5	0.2	1
SN74L95	TIX	10.00	15	11.	32.5	0.3	1
SN74L95	TIX	10.00	15	7.	27.5	0.3	1
SN74L95	TIX	10.00	15	10.	31.1	0.3	1
SN74S00	TIX	10.00	-1	33.	8.3	4.0	1
SN74S00	TIX	10.00	-1	39.	8.8	4.5	1
SN74S00	TIX	10.00	-1	36.	8.1	4.4	1
SN74S00	TIX	10.00	-1	37.	8.1	4.6	1
SN74S00	TIX	10.00	1	-1.	-1.0	-1.0	1
SN74S00	TIX	10.00	1	2.	11.4	0.1	1
SN74S00	TIX	10.00	1	1.	11.5	0.1	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74S00	TIX	10.00	1	3.	15.3	0.2	1
SN74S00	TIX	1.00	1	5.	17.2	0.3	1
SN74S00	TIX	1.00	1	6.	18.6	0.3	1
SN74S00	TIX	1.00	1	3.	15.0	0.2	1
SN74S00	TIX	1.00	1	5.	15.1	0.3	1
SN74S00	TIX	10.00	-2	36.	10.0	3.7	1
SN74S00	TIX	10.00	-2	43.	10.8	4.0	1
SN74S00	TIX	10.00	-2	32.	9.0	3.5	1
SN74S00	TIX	10.00	-2	46.	11.4	4.0	1
SN74S00	TIX	10.00	2	8.	10.8	0.8	1
SN74S00	TIX	10.00	2	7.	8.5	0.9	1
SN74S00	TIX	10.00	2	7.	10.0	0.7	1
SN74S00	TIX	10.00	2	8.	8.4	0.9	1
SN74S00	TIX	1.00	2	29.	15.0	1.9	1
SN74S00	TIX	1.00	2	32.	15.0	2.1	1
SN74S00	TIX	1.00	2	29.	16.0	1.8	1
SN74S00	TIX	1.00	2	38.	18.0	2.1	1
9046	FSC	0.03	2	1035.	115.0	9.0	2
9046	FSC	0.06	2	267.	58.0	4.6	2
9046	FSC	0.10	2	158.	48.0	3.3	2
9046	FSC	0.64	2	57.	34.0	1.7	2
6041	AML	0.03	-1	-1.	115.0	-1.0	2
6041	AML	0.10	-1	-1.	75.0	-1.0	2
SN7491A	TIX	0.30	1	17.	30.0	0.6	8
SN7491A	TIX	0.30	1	24.	35.0	0.7	8
SN7491A	TIX	0.30	1	34.	45.0	0.8	8
SN7491A	TIX	0.30	1	44.	50.0	0.9	8
SN7491A	TIX	0.30	-2	39.	15.0	2.6	8
SN7491A	TIX	0.30	-2	61.	17.5	3.5	8
SN7491A	TIX	0.30	-2	58.	17.5	3.3	8
SN7491A	TIX	0.30	-2	82.	20.0	4.1	8
SN7491A	TIX	0.30	-8	42.	60.0	0.7	8
SN7491A	TIX	0.30	-8	61.	70.0	0.9	8
SN7491A	TIX	0.30	8	45.	45.0	1.0	8
SN7491A	TIX	0.30	8	68.	50.0	1.3	8
SN7491A	TIX	0.30	-3	120.	40.0	3.0	8
SN7491A	TIX	0.30	3	156.	60.0	2.6	8
SN7472N	TIX	0.30	-1	47.	17.5	2.7	8
SN7472N	TIX	0.30	-1	68.	20.0	3.4	8
SN7472N	TIX	0.30	1	12.	20.0	0.6	8
SN7472N	TIX	0.30	1	26.	25.0	1.0	8
SN7472N	TIX	0.30	-2	62.	15.0	4.1	8
SN7472N	TIX	0.30	-2	95.	17.5	5.4	8
SN7472N	TIX	0.30	2	83.	25.0	3.3	8
SN7472N	TIX	0.30	2	135.	30.0	4.5	8
SN7472N	TIX	0.30	2	126.	30.0	4.2	8
SN7472N	TIX	0.30	2	189.	35.0	5.4	8
SN7472N	TIX	0.30	-11	77.	22.5	3.4	8
SN7472N	TIX	0.30	-11	144.	30.0	4.8	8
SN7472N	TIX	0.30	11	45.	25.0	1.8	8
SN7472N	TIX	0.30	11	75.	30.0	2.5	8
SN7472N	TIX	0.30	-3	336.	70.0	4.8	8

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN7472N	TIX	0.30	-3	448.	80.0	5.6	8
SN7472N	TIX	0.30	3	240.	80.0	3.0	8
SN7472N	TIX	0.30	3	360.	90.0	4.0	8
SN74H05	TIX	0.30	3	135.	60.0	2.3	2
SN74H05	TIX	0.30	3	252.	70.0	3.6	2
SN74H05	TIX	0.30	-1	62.	20.0	3.1	2
SN74H05	TIX	0.30	-1	78.	23.0	3.4	2
SN74H05	TIX	0.30	1	16.	20.0	0.8	2
SN74H05	TIX	0.30	1	19.	21.0	0.9	2
SN74H05	TIX	0.30	-2	100.	20.0	5.0	2
SN74H05	TIX	0.30	-2	138.	23.0	6.0	2
SN74H05	TIX	0.30	2	54.	40.0	1.4	2
SN74H05	TIX	0.30	2	74.	45.0	1.6	2
54L00	A	0.10	1	14.	-1.0	-1.0	9
54L00	A	0.10	1	24.	-1.0	-1.0	9
54L00	A	1.00	1	5.	-1.0	-1.0	9
54L00	A	1.00	1	6.	-1.0	-1.0	9
54L00	A	10.00	1	3.	-1.0	-1.0	9
54L00	A	10.00	1	4.	-1.0	-1.0	9
54L04	C	0.10	1	62.	-1.0	-1.0	9
54L04	C	0.10	1	80.	-1.0	-1.0	9
54L04	C	1.00	1	15.	-1.0	-1.0	9
54L04	C	1.00	1	18.	-1.0	-1.0	9
54L04	C	10.00	1	7.	-1.0	-1.0	9
54L04	C	10.00	1	8.	-1.0	-1.0	9
54L04	A	0.10	1	57.	-1.0	-1.0	9
54L04	A	0.10	1	91.	-1.0	-1.0	9
54L04	A	1.00	1	9.	-1.0	-1.0	9
54L04	A	1.00	1	11.	-1.0	-1.0	9
54L04	A	10.00	1	6.	-1.0	-1.0	9
54L04	A	10.00	1	7.	-1.0	-1.0	9
54L10	C	0.10	1	20.	-1.0	-1.0	9
54L10	C	0.10	1	25.	-1.0	-1.0	9
54L10	C	1.00	1	4.	-1.0	-1.0	9
54L10	C	1.00	1	5.	-1.0	-1.0	9
54L10	C	10.00	1	2.	-1.0	-1.0	9
54L10	C	10.00	1	3.	-1.0	-1.0	9
F9344	FSC	2.90	1	58.	-1.0	-1.0	4
SN5420	TIX	0.10	1	120.	-1.0	-1.0	4
SN5420	TIX	0.15	1	107.	-1.0	-1.0	4
SN5420	TIX	0.40	1	38.	-1.0	-1.0	4
SN5420	TIX	0.60	1	50.	-1.0	-1.0	4
SN5420	TIX	0.90	1	33.	-1.0	-1.0	4
SN5420	TIX	1.00	1	30.	-1.0	-1.0	4
SN5420	TIX	0.40	1	38.	-1.0	-1.0	4
SN5420	TIX	0.40	1	38.	-1.0	-1.0	4
SN5420	TIX	0.50	1	70.	-1.0	-1.0	4
SN5420	TIX	1.00	1	25.	-1.0	-1.0	4
SN5420	TIX	1.20	1	42.	-1.0	-1.0	4
SN5420	TIX	1.30	1	46.	-1.0	-1.0	4
SN5420	TIX	6.00	1	8.	-1.0	-1.0	4
SN5420	TIX	3.80	2	30.	-1.0	-1.0	4

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN5420	TIX	3.90	2	40.	-1.0	-1.0	4
SN5420	TIX	2.70	2	24.	-1.0	-1.0	4
SN5420	TIX	2.40	2	35.	-1.0	-1.0	4
SN5420	TIX	2.80	3	77.	-1.0	-1.0	4
SN5420	TIX	3.00	3	80.	-1.0	-1.0	4
DRA2001	TIX	2.50	1	56.	-1.0	-1.0	4
DRA2001	TIX	2.50	1	62.	-1.0	-1.0	4
SN74L00	TIX	0.25	-2	67.	18.0	3.7	8
SN74L00	TIX	0.25	-2	86.	20.0	4.3	8
SN74L00	TIX	0.25	2	58.	33.0	1.8	8
SN74L00	TIX	0.25	2	70.	35.0	2.0	8
SN74L00	TIX	0.25	3	255.	58.0	4.4	8
SN74L00	TIX	0.25	3	282.	60.0	4.7	8
SN74L00	TIX	0.20	-1	62.	60.0	1.0	8
SN74L00	TIX	0.20	-1	83.	67.0	1.2	8
SN74L00	TIX	0.20	1	23.	44.0	0.5	8
SN74L00	TIX	0.20	1	39.	50.0	0.8	8
SN74L00	TIX	0.20	1	25.	40.0	0.6	8
SN74L00	TIX	0.20	1	36.	45.0	0.8	8
SN5404	TIX	1.00	1	23.	32.9	0.7	5
SN5404	TIX	1.00	1	76.	44.7	1.7	5
SN5404	TIX	1.00	1	34.	48.6	0.7	5
SN5404	TIX	1.00	1	57.	47.5	1.2	5
SN5404	TIX	1.00	1	10.	25.0	0.4	5
SN5404	TIX	1.00	1	47.	39.2	1.2	5
SN5404	TIX	1.00	1	50.	41.7	1.2	5
SN5404	TIX	1.00	1	87.	41.4	2.1	5
SN5404	TIX	1.00	1	62.	38.8	1.6	5
SN5404	TIX	1.00	1	79.	37.6	2.1	5
SN5404	TIX	0.11	1	300.	107.1	2.8	5
SN5404	TIX	0.11	1	260.	81.3	3.2	5
SN5404	TIX	0.11	1	280.	80.0	3.5	5
SN5404	TIX	0.11	1	350.	87.5	4.0	5
SN5404	TIX	0.11	1	118.	59.0	2.0	5
SN5404	TIX	0.11	1	190.	76.0	2.5	5
SN5404	TIX	0.11	1	100.	55.6	1.8	5
SN5404	TIX	0.11	1	180.	72.0	2.5	5
SN5404	TIX	0.11	1	110.	64.7	1.7	5
SN5404	TIX	0.11	1	180.	72.0	2.5	5
SN5404	TIX	0.01	1	3000.	214.3	14.0	5
SN5404	TIX	0.01	1	5000.	277.8	18.0	5
SN5404	TIX	0.01	1	2200.	183.3	12.0	5
SN5404	TIX	0.01	1	3200.	213.3	15.0	5
SN5404	TIX	0.01	1	2200.	183.3	12.0	5
SN5404	TIX	0.01	1	2700.	207.7	13.0	5
SN5404	TIX	0.01	1	2200.	183.3	12.0	5
SN5404	TIX	0.01	1	2700.	207.7	13.0	5
SN5404	TIX	0.01	1	3200.	213.3	15.0	5
SN5404	TIX	0.01	1	3900.	229.4	17.0	5
SN5404	TIX	1.00	-1	95.	50.0	1.9	5
SN5404	TIX	1.00	-1	160.	57.1	2.8	5
SN5404	TIX	1.00	-1	110.	61.1	1.8	5

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN5404	TIX	1.00	-1	180.	56.3	3.2	5
SN5404	TIX	1.00	-1	120.	60.0	2.0	5
SN5404	TIX	1.00	-1	160.	53.3	3.0	5
SN5404	TIX	1.00	-1	120.	63.2	1.9	5
SN5404	TIX	1.00	-1	210.	70.0	3.0	5
SN5404	TIX	1.00	-1	200.	71.4	2.8	5
SN5404	TIX	1.00	-1	230.	57.5	4.0	5
SN5404	TIX	0.11	-1	310.	88.6	3.5	5
SN5404	TIX	0.11	-1	370.	92.5	4.0	5
SN5404	TIX	0.11	-1	290.	87.9	3.3	5
SN5404	TIX	0.11	-1	340.	85.0	4.0	5
SN5404	TIX	0.11	-1	280.	87.5	3.2	5
SN5404	TIX	0.11	-1	370.	92.5	4.0	5
SN5404	TIX	0.11	-1	310.	93.9	3.3	5
SN5404	TIX	0.11	-1	360.	90.0	4.0	5
SN5404	TIX	0.11	-1	670.	117.5	5.7	5
SN5404	TIX	0.11	-1	680.	97.1	7.0	5
SN5404	TIX	0.01	-1	830.	138.3	6.0	5
SN5404	TIX	0.01	-1	500.	71.4	7.0	5
SN5404	TIX	0.01	-1	750.	150.0	5.0	5
SN5404	TIX	0.01	-1	420.	60.0	7.0	5
SN5404	TIX	0.01	-1	330.	82.5	4.0	5
SN5404	TIX	0.01	-1	330.	82.5	4.0	5
SN5404	TIX	0.01	-1	420.	105.0	4.0	5
SN5404	TIX	0.01	-1	330.	60.0	5.5	5
SN5404	TIX	0.01	-1	500.	100.0	5.0	5
SN5404	TIX	0.01	-1	420.	76.4	5.5	5
SN5404	TIX	1.00	2	140.	33.3	4.2	5
SN5404	TIX	1.00	2	160.	34.8	4.6	5
SN5404	TIX	1.00	2	48.	30.0	1.6	5
SN5404	TIX	1.00	2	92.	30.7	3.0	5
SN5404	TIX	1.00	2	49.	24.5	2.0	5
SN5404	TIX	1.00	2	67.	25.8	2.6	5
SN5404	TIX	1.00	2	88.	27.5	3.2	5
SN5404	TIX	1.00	2	72.	18.0	4.0	5
SN5404	TIX	1.00	2	110.	30.6	3.6	5
SN5404	TIX	1.00	2	110.	25.6	4.3	5
SN5404	TIX	0.11	2	690.	57.5	12.0	5
SN5404	TIX	0.11	2	590.	42.1	14.0	5
SN5404	TIX	0.11	2	540.	56.8	9.5	5
SN5404	TIX	0.11	2	450.	40.9	11.0	5
SN5404	TIX	0.11	2	690.	69.0	10.0	5
SN5404	TIX	0.11	2	-1.	1.0	-1.0	5
SN5404	TIX	0.11	2	810.	57.9	14.0	5
SN5404	TIX	0.11	2	730.	48.7	15.0	5
SN5404	TIX	0.11	2	820.	58.6	14.0	5
SN5404	TIX	0.11	2	800.	53.3	15.0	5
SN5404	TIX	0.01	2	4100.	136.7	30.0	5
SN5404	TIX	0.01	2	6000.	150.0	40.0	5
SN5404	TIX	0.01	2	5800.	128.9	45.0	5
SN5404	TIX	0.01	2	7000.	140.0	50.0	5
SN5404	TIX	0.01	2	6700.	148.9	45.0	5

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN5404	TIX	0.01	2	7700.	160.4	48.0	5
SN5404	TIX	0.01	2	5600.	140.0	40.0	5
SN5404	TIX	0.01	2	7000.	155.6	45.0	5
SN5404	TIX	0.01	2	4200.	140.0	30.0	5
SN5404	TIX	0.01	2	5600.	160.0	35.0	5
SN5404	TIX	1.00	-2	40.	15.4	2.6	5
SN5404	TIX	1.00	-2	75.	19.7	3.8	5
SN5404	TIX	1.00	-2	47.	16.8	2.8	5
SN5404	TIX	1.00	-2	58.	17.6	3.3	5
SN5404	TIX	1.00	-2	34.	14.8	2.3	5
SN5404	TIX	1.00	-2	45.	16.7	2.7	5
SN5404	TIX	1.00	-2	58.	16.6	3.5	5
SN5404	TIX	1.00	-2	62.	15.5	4.0	5
SN5404	TIX	1.00	-2	47.	16.8	2.8	5
SN5404	TIX	1.00	-2	62.	16.8	3.7	5
SN5404	TIX	0.11	-2	840.	49.4	17.0	5
SN5404	TIX	0.11	-2	910.	47.9	19.0	5
SN5404	TIX	0.11	-2	620.	41.3	15.0	5
SN5404	TIX	0.11	-2	780.	48.8	16.0	5
SN5404	TIX	0.11	-2	450.	34.6	13.0	5
SN5404	TIX	0.11	-2	530.	37.9	14.0	5
SN5404	TIX	0.11	-2	660.	38.8	17.0	5
SN5404	TIX	0.11	-2	840.	44.2	19.0	5
SN5404	TIX	0.11	-2	550.	34.4	16.0	5
SN5404	TIX	0.11	-2	700.	41.2	17.0	5
SN5404	TIX	0.01	-2	6000.	120.0	50.0	5
SN5404	TIX	0.01	-2	7400.	134.5	55.0	5
SN5404	TIX	0.01	-2	2900.	72.5	40.0	5
SN5404	TIX	0.01	-2	3700.	84.1	44.0	5
SN5404	TIX	0.01	-2	1800.	60.0	30.0	5
SN5404	TIX	0.01	-2	2700.	77.1	35.0	5
SN5404	TIX	0.01	-2	5000.	100.0	50.0	5
SN5404	TIX	0.01	-2	8200.	149.1	55.0	5
SN5404	TIX	0.01	-2	6100.	110.9	55.0	5
SN5404	TIX	0.01	-2	7200.	120.0	60.0	5
SN5404	TIX	1.00	3	340.	94.4	3.6	5
SN5404	TIX	1.00	3	190.	43.2	4.4	5
SN5404	TIX	1.00	3	1100.	110.0	10.0	5
SN5404	TIX	1.00	3	1300.	86.7	15.0	5
SN5404	TIX	1.00	3	180.	90.0	2.0	5
SN5404	TIX	1.00	3	270.	75.0	3.6	5
SN5404	TIX	1.00	3	470.	78.3	6.0	5
SN5404	TIX	1.00	3	590.	73.8	8.0	5
SN5404	TIX	1.00	3	690.	84.1	8.2	5
SN5404	TIX	1.00	3	890.	80.9	11.0	5
SN5404	TIX	0.11	3	2700.	103.8	26.0	5
SN5404	TIX	0.11	3	4200.	123.5	34.0	5
SN5404	TIX	0.11	3	9100.	175.0	52.0	5
SN5404	TIX	0.11	3	10000.	166.7	60.0	5
SN5404	TIX	0.11	3	7100.	177.5	40.0	5
SN5404	TIX	0.11	3	8400.	186.7	45.0	5
SN5404	TIX	0.11	3	5900.	147.5	40.0	5

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN5404	TIX	0.11	3	8000.	177.8	45.0	5
SN5404	TIX	0.11	3	6300.	157.5	40.0	5
SN5404	TIX	0.11	3	8100.	176.1	46.0	5
SN5404	TIX	0.01	3	68000.	377.8	180.0	5
SN5404	TIX	0.01	3	80000.	421.1	190.0	5
SN5404	TIX	0.01	3	80000.	421.1	190.0	5
SN5404	TIX	0.01	3	-1.	1.0	-1.0	5
SN5404	TIX	0.01	3	81000.	405.0	200.0	5
SN5404	TIX	0.01	3	-1.	1.0	-1.0	5
SN5404	TIX	0.01	3	80000.	400.0	200.0	5
SN5404	TIX	0.01	3	83000.	415.0	200.0	5
SN5404	TIX	0.01	3	68000.	357.9	190.0	5
SN5404	TIX	0.01	3	76000.	380.0	200.0	5
SN5404	TIX	1.00	-3	330.	38.8	8.5	5
SN5404	TIX	1.00	-3	260.	28.3	9.2	5
SN5404	TIX	1.00	-3	310.	36.5	8.5	5
SN5404	TIX	1.00	-3	250.	27.8	9.0	5
SN5404	TIX	1.00	-3	390.	46.4	8.4	5
SN5404	TIX	1.00	-3	550.	64.0	8.6	5
SN5404	TIX	1.00	-3	450.	40.9	11.0	5
SN5404	TIX	1.00	-3	300.	23.1	13.0	5
SN5404	TIX	1.00	-3	650.	40.6	16.0	5
SN5404	TIX	1.00	-3	1100.	61.1	18.0	5
SN5404	TIX	0.10	-3	7000.	140.0	50.0	5
SN5404	TIX	0.10	-3	9200.	167.3	55.0	5
SN5404	TIX	0.10	-3	7000.	140.0	50.0	5
SN5404	TIX	0.10	-3	11000.	183.3	60.0	5
SN5404	TIX	0.10	-3	6100.	145.2	42.0	5
SN5404	TIX	0.10	-3	7000.	155.6	45.0	5
SN5404	TIX	0.10	-3	6300.	146.5	43.0	5
SN5404	TIX	0.10	-3	7000.	155.6	45.0	5
SN5404	TIX	0.10	-3	5000.	125.0	40.0	5
SN5404	TIX	0.10	-3	5600.	124.4	45.0	5
SN5404	TIX	0.01	-3	19000.	237.5	80.0	5
SN5404	TIX	0.01	-3	43000.	307.1	140.0	5
SN5404	TIX	0.01	-3	31000.	258.3	120.0	5
SN5404	TIX	0.01	-3	60000.	300.0	200.0	5
SN5404	TIX	0.01	-3	36000.	300.0	120.0	5
SN5404	TIX	0.01	-3	42000.	300.0	140.0	5
SN5404	TIX	0.01	-3	21000.	210.0	100.0	5
SN5404	TIX	0.01	-3	24000.	200.0	120.0	5
SN5404	TIX	0.01	-3	36000.	300.0	120.0	5
SN5404	TIX	0.01	-3	49000.	376.9	130.0	5
54L00	TIX	0.28	-1	384.	80.0	4.8	12
54L00	TIX	1.00	-1	380.	50.0	7.6	12
54L00	TIX	0.44	-1	384.	70.0	5.5	12
54L00	TIX	0.24	-1	475.	85.0	5.6	12
54L00	TIX	0.66	-1	364.	70.0	5.2	12
54L00	TIX	0.56	-1	422.	65.0	5.6	12
54L00	TIX	0.54	-1	364.	70.0	5.2	12
54L00	TIX	0.6[illegible]	-1	405.	75.0	5.4	12
54L00	TIX	0.24	-1	391.	85.0	4.6	12

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
54L00	TIX	0.68	-1	480.	80.0	6.0	12
54L00	TIX	0.48	-1	352.	80.0	4.4	12
54L00	TIX	0.20	-1	540.	100.0	5.4	12
54L00	TIX	0.24	1	111.	61.5	1.8	12
54L00	TIX	0.46	1	110.	55.0	2.0	12
54L00	TIX	0.25	1	144.	60.0	2.4	12
54L00	TIX	0.22	1	130.	50.0	2.6	12
54L00	TIX	0.24	1	126.	45.0	2.8	12
54L00	TIX	0.30	1	144.	60.0	2.4	12
54L00	TIX	0.36	1	89.	55.0	1.6	12
54L00	TIX	0.24	1	144.	60.0	2.4	12
54L00	TIX	0.28	1	126.	45.0	2.8	12
54L00	TIX	0.28	1	138.	55.0	2.5	12
54L00	TIX	0.28	1	90.	50.0	1.8	12
54L00	TIX	0.24	1	108.	40.0	2.7	12
54L00	TIX	0.34	1	114.	47.5	2.4	12
54L00	TIX	0.38	1	117.	45.0	2.6	12
54L00	TIX	0.05	1	700.	120.0	6.0	12
54L00	TIX	0.05	1	1200.	130.0	9.0	12
54L00	TIX	0.06	1	1200.	130.0	9.5	12
54L00	TIX	0.05	1	1100.	110.0	9.5	12
54L00	TIX	0.05	1	1100.	115.0	9.2	12
54L00	TIX	0.05	1	950.	130.0	7.6	12
54L00	TIX	0.05	1	950.	135.0	7.2	12
54L00	TIX	0.07	1	1150.	115.0	10.0	12
54L00	TIX	0.07	1	1000.	110.0	9.5	12
54L00	TIX	0.07	1	800.	95.0	8.7	12
54L00	TIX	0.07	-1	840.	100.0	8.5	12
54L00	TIX	0.07	-1	1650.	140.0	11.5	12
54L00	TIX	0.07	-1	1300.	125.0	10.5	12
54L00	TIX	0.07	-1	1300.	110.0	12.0	12
54L00	TIX	0.07	-1	1400.	130.0	11.0	12
54L00	TIX	0.07	-1	1400.	130.0	11.5	12
54L00	TIX	0.10	-1	1500.	150.0	10.0	12
54L00	TIX	0.10	-1	1170.	90.0	13.0	12
54L00	TIX	0.10	-1	1000.	100.0	10.0	12
54L00	TIX	0.10	-1	2080.	160.0	13.0	12
54L122	TIX	1.00	1	62.	44.0	1.5	12
54L122	TIX	1.00	2	45.	22.5	2.0	12
54L122	TIX	1.00	1	250.	60.0	4.3	12
54L122	TIX	1.00	2	60.	24.0	2.5	12
54L122	TIX	1.00	1	245.	59.0	4.3	12
54L122	TIX	1.00	2	59.	12.5	4.8	12
54L122	TIX	1.00	-2	160.	26.0	7.2	12
54L122	TIX	1.00	-1	8.	11.2	0.7	12
54L122	TIX	1.00	-2	211.	25.0	8.5	12
54L122	TIX	1.00	-1	24.	51.0	0.6	12
54L122	TIX	1.00	2	354.	220.0	1.6	12
54L122	TIX	1.00	1	64.	29.0	2.2	12
54L122	TIX	0.90	2	55.	26.0	2.6	12
54L122	TIX	1.00	-1	78.	45.0	2.2	12
54L122	TIX	1.00	2	104.	22.6	5.1	12

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
54L122	TIX	1.00	-2	131.	28.0	6.0	12
MC308G	MOT	10.00	-1	23.	19.[illegible]	1.2	1
MC308G	MOT	10.00	-1	32.	21[illegible]	1.5	1
MC308G	MOT	10.00	-1	36.	2[illegible].5	1.6	1
MC308G	MOT	10.00	-1	35.	1[illegible].8	2.0	1
MC308G	MOT	10.00	1	17.	11.0	1.5	1
MC308G	MOT	10.00	1	28.	15.7	2.0	1
MC308G	MOT	10.00	1	28.	14.0	2.0	1
MC308G	MOT	10.00	1	38.	16.0	2.4	1
MC308G	MOT	1.00	-1	94.	41.4	2.4	1
MC308G	MOT	1.00	-1	81.	30.2	2.7	1
MC308G	MOT	10.00	-2	20.	15.8	1.2	1
MC308G	MOT	10.00	-2	20.	15.5	1.3	1
MC308G	MOT	10.00	-2	18.	16.5	1.1	1
MC308G	MOT	10.00	-2	25.	17.5	1.5	1
MC308G	MOT	10.00	2	7.	10.3	0.7	1
MC308G	MOT	10.00	2	9.	11.3	0.8	1
MC308G	MOT	1.00	2	15.	15.5	1.0	1
MC308G	MOT	1.00	2	19.	15.3	1.2	1
MC308G	MOT	1.00	2	11.	15.8	0.7	1
MC308G	MOT	1.00	2	10.	12.4	0.9	1
MC308G	MOT	0.10	2	72.	30.0	2.4	1
MC308G	MOT	0.10	2	111.	37.0	3.0	1
MC308G	MOT	0.10	2	49.	27.0	1.8	1
MC308G	MOT	0.10	2	62.	28.0	2.2	1
MC308G	MOT	10.00	-3	221.	43.0	5.2	1
MC308G	MOT	10.00	-3	235.	47.0	5.0	1
MC308G	MOT	10.00	-3	144.	30.0	4.8	1
MC308G	MOT	10.00	-3	182.	35.2	5.2	1
MC308G	MOT	10.00	3	181.	56.2	3.2	1
MC308G	MOT	10.00	3	227.	59.9	3.8	1
MC308G	MOT	10.00	3	126.	63.0	2.0	1
MC308G	MOT	10.00	3	143.	65.0	2.2	1
MC308G	MOT	10.00	-3	158.	36.0	4.4	1
MC308G	MOT	10.00	-3	190.	39.7	4.8	1
MC308G	MOT	1.00	3	414.	74.0	5.6	1
MC308G	MOT	1.00	3	768.	96.0	8.0	1
MC317F	MOT	10.00	-1	7.	39.0	0.2	1
MC317F	MOT	10.00	-1	15.	31.8	0.5	1
MC317F	MOT	10.00	-1	7.	39.5	0.2	1
MC317F	MOT	10.00	-1	8.	42.2	0.2	1
MC317F	MOT	10.00	1	24.	21.5	1.1	1
MC317F	MOT	10.00	1	32.	21.4	1.5	1
MC317F	MOT	10.00	1	61.	26.5	2.3	1
MC317F	MOT	10.00	1	83.	32.0	2.6	1
MC317F	MOT	1.00	-1	118.	56.0	2.1	1
MC317F	MOT	1.00	-1	150.	60.0	2.5	1
MC317F	MOT	1.00	-1	146.	56.0	2.6	1
MC317F	MOT	1.00	-1	192.	62.0	3.1	1
MC317F	MOT	0.10	-1	147.	105.0	1.4	1
MC317F	MOT	0.10	-1	188.	90.0	2.2	1
MC317F	MOT	0.10	-1	182.	90.0	2.1	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC317F	MOT	0.10	-1	224.	70.0	3.2	1
MC317F	MOT	10.00	-2	26.	12.4	2.1	1
MC317F	MOT	10.00	-2	36.	14.4	2.5	1
MC317F	MOT	10.00	-2	28.	14.8	1.9	1
MC317F	MOT	10.00	-2	38.	15.4	2.5	1
MC317F	MOT	10.00	2	55.	39.5	1.4	1
MC317F	MOT	10.00	2	65.	37.8	1.9	1
MC317F	MOT	10.00	2	49.	39.5	1.3	1
MC317F	MOT	10.00	2	68.	41.5	1.8	1
MC317F	MOT	1.00	-2	127.	21.5	5.9	1
MC317F	MOT	1.00	-2	129.	19.5	6.7	1
MC317F	MOT	1.00	-2	95.	20.5	4.7	1
MC317F	MOT	1.00	-2	119.	21.5	5.6	1
MC317F	MOT	10.00	-3	87.	70.0	1.3	1
MC317F	MOT	10.00	-3	147.	83.1	1.8	1
MC317F	MOT	10.00	-3	166.	76.0	2.2	1
MC317F	MOT	10.00	-3	218.	85.5	2.6	1
MC317F	MOT	10.00	3	112.	60.0	2.0	1
MC317F	MOT	10.00	3	109.	44.3	2.5	1
MC317F	MOT	10.00	3	104.	64.0	1.7	1
MC317F	MOT	10.00	3	109.	44.3	2.5	1
MC317F	MOT	1.00	3	424.	80.0	5.3	1
MC317F	MOT	1.00	3	554.	88.0	6.3	1
MC317F	MOT	1.00	3	355.	90.0	4.0	1
MC317F	MOT	1.00	3	410.	80.0	5.2	1
MC304G	MOT	0.10	-1	704.	88.0	8.0	1
MC304G	MOT	0.10	-1	779.	95.0	8.2	1
MC304G	MOT	10.00	-1	39.	41.8	0.9	1
MC304G	MOT	10.00	-1	45.	33.2	1.5	1
MC304G	MOT	10.00	-1	54.	46.0	1.2	1
MC304G	MOT	10.00	-1	61.	43.0	1.5	1
MC304G	MOT	10.00	2	36.	12.0	3.0	1
MC304G	MOT	10.00	2	45.	14.2	3.2	1
MC304G	MOT	10.00	2	48.	14.0	3.4	1
MC304G	MOT	10.00	2	58.	15.7	3.7	1
MC304G	MOT	1.00	2	342.	45.0	7.6	1
MC304G	MOT	1.00	2	448.	54.0	8.3	1
MC304G	MOT	1.00	2	295.	48.0	6.2	1
MC304G	MOT	1.00	2	330.	49.0	6.8	1
MC304G	MOT	10.00	1	90.	25.8	3.7	1
MC304G	MOT	10.00	1	112.	26.8	4.3	1
MC304G	MOT	10.00	1	77.	22.0	3.7	1
MC304G	MOT	10.00	1	81.	20.4	4.2	1
MC304G	MOT	10.00	-1	55.	24.0	2.3	1
MC304G	MOT	10.00	-1	135.	26.0	5.2	1
MC304G	MOT	10.00	-1	53.	27.2	2.0	1
MC304G	MOT	10.00	-1	69.	29.2	2.4	1
MC304G	MOT	1.00	-1	344.	60.0	5.8	1
MC304G	MOT	1.00	-1	395.	56.3	7.0	1
MC304G	MOT	1.00	-1	402.	70.0	5.8	1
MC304G	MOT	1.00	-1	389.	59.9	6.5	1
MC304G	MOT	0.10	-1	680.	85.0	8.0	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
MC304G	MOT	0.10	-1	810.	90.0	9.0	1
MC304G	MOT	0.10	2	495.	55.0	9.0	1
MC304G	MOT	0.10	2	588.	60.0	9.8	1
MC304G	MOT	10.00	-3	109.	27.0	4.1	1
MC304G	MOT	10.00	-3	147.	37.8	4.0	1
MC304G	MOT	10.00	3	121.	33.5	3.6	1
MC304G	MOT	10.00	3	189.	43.5	4.4	1
MC304G	MOT	10.00	3	92.	32.5	3.1	1
MC304G	MOT	10.00	3	82.	25.2	3.6	1
MC1678L	MOT	0.10	-1	700.	-1.0	-1.0	4
MC1678L	MOT	0.16	-1	450.	-1.0	-1.0	4
MC351G	MOT	0.32	-1	14.	-1.0	-1.0	4
MC351G	MOT	0.52	-1	11.	-1.0	-1.0	4
MC351G	MOT	0.52	-1	14.	-1.0	-1.0	4
MC351G	MOT	0.70	-1	7.	-1.0	-1.0	4
MC351G	MOT	1.00	-1	11.	-1.0	-1.0	4
MC351G	MOT	1.50	-1	6.	-1.0	-1.0	4
MC351G	MOT	1.50	-1	5.	-1.0	-1.0	4
MC351G	MOT	3.00	-1	10.	-1.0	-1.0	4
MC351G	MOT	4.00	-1	4.	-1.0	-1.0	4
MC351G	MOT	7.00	-1	8.	-1.0	-1.0	4
MC351G	MOT	0.52	-1	20.	-1.0	-1.0	4
MC301G	MOT	0.10	1	1150.	115.0	10.0	3
MC301G	MOT	1.00	1	660.	110.0	6.0	3
MC301G	MOT	10.00	1	40.	20.0	2.0	3
MC301G	MOT	0.10	2	1350.	150.0	9.0	3
MC301G	MOT	1.00	2	304.	80.0	3.8	3
MC301G	MOT	10.00	2	34.	24.0	1.4	3
MC301G	MOT	1.70	3	1440.	160.0	9.0	3
MC301G	MOT	2.00	3	1440.	160.0	9.0	3
MC301G	MOT	10.00	3	84.	30.0	2.8	3
LM105	NSC	10.00	-2	22.	15.1	1.5	1
LM105	NSC	10.00	-2	22.	13.6	1.7	1
LM105	NSC	10.00	-2	19.	13.8	1.3	1
LM105	NSC	10.00	-2	19.	12.2	1.6	1
LM105	NSC	10.00	2	42.	131.0	0.3	1
LM105	NSC	10.00	2	88.	65.3	1.4	1
LM105	NSC	10.00	2	47.	131.0	0.4	1
LM105	NSC	10.00	2	139.	75.2	1.9	1
LM105	NSC	1.00	-2	114.	36.2	3.2	1
LM105	NSC	1.00	-2	137.	37.0	3.8	1
LM105	NSC	1.00	-2	123.	38.6	3.2	1
LM105	NSC	1.00	-2	145.	38.8	3.8	1
LM105	NSC	0.10	-2	1035.	115.0	9.0	1
LM105	NSC	0.10	-2	1292.	123.0	10.5	1
LM105	NSC	0.10	-2	1107.	123.0	9.0	1
LM105	NSC	0.10	-2	1365.	130.0	10.5	1
LM105	NSC	10.00	-7	14.	27.0	0.6	1
LM105	NSC	10.00	-7	17.	20.8	0.8	1
LM105	NSC	10.00	-7	14.	28.6	0.6	1
LM105	NSC	10.00	-7	10.	12.3	0.8	1
LM105	NSC	10.00	7	20.	119.0	0.2	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
LM105	NSC	10.00	7	60.	64.2	1.4	1
LM105	NSC	10.00	7	29.	119.0	0.2	1
LM105	NSC	10.00	7	65.	42.0	1.9	1
LM105	NSC	1.00	-7	57.	33.2	1.7	1
LM105	NSC	1.00	-7	71.	35.5	2.0	1
LM105	NSC	1.00	-7	59.	32.7	1.8	1
LM105	NSC	1.00	-7	66.	33.4	2.0	1
LM105	NSC	0.10	-7	378.	88.0	4.3	1
LM105	NSC	0.10	-7	510.	100.0	5.1	1
LM105	NSC	0.10	-7	414.	94.0	4.4	1
LM105	NSC	0.10	-7	485.	101.0	4.8	1
LM105	NSC	10.00	-11	20.	18.0	1.1	1
LM105	NSC	10.00	-11	24.	18.6	1.3	1
LM105	NSC	10.00	-11	23.	20.0	1.2	1
LM105	NSC	10.00	-11	28.	21.0	1.4	1
LM105	NSC	10.00	11	-1.	-1.0	-1.0	1
LM105	NSC	10.00	11	129.	99.6	1.3	1
LM105	NSC	10.00	11	92.	147.0	0.6	1
LM105	NSC	10.00	11	135.	121.0	1.2	1
LM105	NSC	1.00	-11	67.	30.7	2.2	1
LM105	NSC	1.00	-11	91.	36.3	2.5	1
LM105	NSC	1.00	-11	96.	36.6	2.6	1
LM105	NSC	1.00	-11	112.	39.8	2.8	1
LM105	NSC	0.10	-11	675.	90.0	7.5	1
LM105	NSC	0.10	-11	850.	100.0	8.5	1
LM105	NSC	0.10	-11	576.	90.0	6.4	1
LM105	NSC	0.10	-11	760.	95.0	8.0	1
LM105	NSC	10.00	-12	-1.	-1.0	-1.0	1
LM105	NSC	10.00	-12	20.	40.6	0.6	1
LM105	NSC	10.00	12	50.	33.0	1.5	1
LM105	NSC	10.00	12	85.	48.0	1.8	1
LM105	NSC	10.00	12	53.	38.0	1.4	1
LM105	NSC	10.00	12	87.	42.8	2.0	1
LM105	NSC	1.00	-12	31.	27.3	1.2	1
LM105	NSC	1.00	-12	37.	28.5	1.3	1
LM105	NSC	1.00	-12	53.	31.4	1.7	1
LM105	NSC	1.00	-12	64.	33.7	1.9	1
709HC	FSC	0.10	-1	23.	42.0	0.6	1
709HC	FSC	0.10	-1	41.	59.0	0.7	1
709HC	FSC	10.00	-2	36.	14.0	2.6	1
709HC	FSC	10.00	-2	39.	14.1	2.8	1
709HC	FSC	10.00	-2	39.	15.0	2.6	1
709HC	FSC	10.00	-2	55.	19.0	2.9	1
709HC	FSC	10.00	2	51.	37.8	1.5	1
709HC	FSC	10.00	2	54.	28.4	1.9	1
709HC	FSC	10.00	2	37.	21.0	1.9	1
709HC	FSC	10.00	2	42.	19.2	2.3	1
709HC	FSC	1.00	2	195.	53.2	3.7	1
709HC	FSC	1.00	2	182.	44.2	4.2	1
709HC	FSC	10.00	-1	3.	18.0	0.1	1
709HC	FSC	10.00	-1	4.	15.8	0.3	1
709HC	FSC	10.00	-1	3.	19.0	0.1	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
709HC	FSC	10.00	-1	5.	11.7	0.5	1
709HC	FSC	10.00	1	4.	76.0	0.1	1
709HC	FSC	10.00	1	10.	88.5	0.1	1
709HC	FSC	10.00	1	64.	80.0	0.8	1
709HC	FSC	10.00	1	86.	63.4	1.6	1
709HC	FSC	1.00	-1	8.	27.0	0.3	1
709HC	FSC	1.00	-1	9.	23.0	0.4	1
709HC	FSC	0.10	-1	19.	38.0	0.5	1
709HC	FSC	0.10	-1	33.	44.0	0.8	1
709HC	FSC	1.00	-1	5.	22.0	0.2	1
709HC	FSC	1.00	-1	7.	22.8	0.4	1
709HC	FSC	10.00	-3	219.	37.5	5.9	1
709HC	FSC	10.00	-3	271.	39.6	6.9	1
709HC	FSC	10.00	-3	216.	30.0	7.2	1
709HC	FSC	10.00	-3	354.	47.4	7.5	1
709HC	FSC	10.00	3	-1.	-1.0	-1.0	1
709HC	FSC	10.00	3	116.	67.8	2.0	1
709HC	FSC	10.00	3	167.	73.0	2.5	1
709HC	FSC	10.00	3	183.	59.1	3.1	1
UA715	FSC	10.00	-1	66.	29.7	2.9	1
UA715	FSC	10.00	-1	87.	23.1	4.1	1
UA715	FSC	10.00	-1	78.	50.2	1.8	1
UA715	FSC	10.00	-1	138.	52.1	2.9	1
UA715	FSC	10.00	1	147.	80.0	2.1	1
UA715	FSC	10.00	1	312.	75.6	4.3	1
UA715	FSC	10.00	1	319.	71.1	4.8	1
UA715	FSC	10.00	1	328.	62.0	5.6	1
UA715	FSC	1.00	-1	226.	68.0	5.2	1
UA715	FSC	1.00	-1	452.	87.5	5.4	1
UA715	FSC	1.00	-1	295.	77.6	5.5	1
UA715	FSC	1.00	-1	401.	76.6	6.5	1
UA715	FSC	0.10	-1	1377.	192.5	7.5	1
UA715	FSC	0.10	-1	1974.	215.0	9.4	1
UA715	FSC	0.10	-1	1330.	197.5	7.1	1
UA715	FSC	0.10	-1	1961.	201.5	10.3	1
UA715	FSC	10.00	-2	94.	20.5	4.7	1
UA715	FSC	10.00	-2	136.	33.6	4.1	1
UA715	FSC	10.00	-2	113.	25.8	4.6	1
UA715	FSC	10.00	-2	118.	29.7	4.1	1
UA715	FSC	10.00	2	317.	43.5	7.3	1
UA715	FSC	10.00	2	423.	52.8	8.1	1
UA715	FSC	10.00	2	328.	45.0	7.3	1
UA715	FSC	10.00	2	544.	68.0	8.0	1
UA715	FSC	1.00	-2	268.	41.0	6.9	1
UA715	FSC	1.00	-2	316.	44.5	7.4	1
UA715	FSC	1.00	-2	402.	50.6	8.6	1
UA715	FSC	1.00	-2	492.	58.8	8.7	1
UA715	FSC	0.10	-2	1557.	157.5	10.1	1
UA715	FSC	0.10	-2	1896.	142.5	13.4	1
UA715	FSC	0.10	-2	1629.	165.0	10.1	1
UA715	FSC	0.10	-2	1640.	128.3	13.0	1
UA740	FSC	10.00	-1	147.	16.4	9.0	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
UA740	FSC	10.00	-1	396.	47.6	8.4	1
UA740	FSC	10.00	-1	150.	17.0	8.9	1
UA740	FSC	10.00	-1	219.	23.5	9.9	1
UA740	FSC	10.00	1	78.	35.0	2.3	1
UA740	FSC	10.00	1	89.	31.4	3.2	1
UA740	FSC	10.00	1	74.	34.0	2.3	1
UA740	FSC	10.00	1	86.	25.8	3.3	1
UA740	FSC	1.00	1	229.	59.6	3.9	1
UA740	FSC	1.00	1	308.	53.0	5.9	1
UA740	FSC	1.00	1	278.	46.9	6.1	1
UA740	FSC	1.00	1	369.	58.1	6.4	1
UA740	FSC	0.10	1	775.	149.0	5.2	1
UA740	FSC	0.10	1	1011.	158.0	6.4	1
UA740	FSC	0.10	1	948.	158.0	6.0	1
UA740	FSC	0.10	1	1088.	160.0	6.8	1
UA740	FSC	10.00	2	174.	24.0	7.3	1
UA740	FSC	10.00	2	310.	40.1	7.9	1
UA740	FSC	10.00	2	255.	39.5	6.5	1
UA740	FSC	10.00	2	254.	44.7	5.9	1
UA740	FSC	10.00	-2	149.	19.0	7.9	1
UA740	FSC	10.00	-2	282.	37.9	7.4	1
UA740	FSC	10.00	-2	116.	17.0	6.8	1
UA740	FSC	10.00	-2	199.	25.0	8.2	1
UA740	FSC	1.00	-2	719.	54.2	13.3	1
UA740	FSC	1.00	-2	1178.	69.6	17.0	1
UA740	FSC	1.00	-2	698.	52.3	13.4	1
UA740	FSC	1.00	-2	805.	48.9	16.5	1
UA776	FSC	10.00	1	108.	120.0	0.9	1
UA776	FSC	10.00	1	222.	102.0	2.6	1
UA776	FSC	10.00	-12	86.	18.0	4.8	1
UA776	FSC	10.00	-12	137.	29.4	4.8	1
UA776	FSC	10.00	-12	85.	17.0	5.0	1
UA776	FSC	10.00	-12	127.	24.6	5.3	1
UA776	FSC	10.00	12	57.	15.0	3.8	1
UA776	FSC	10.00	12	191.	67.0	3.6	1
UA776	FSC	10.00	12	55.	14.0	3.9	1
UA776	FSC	10.00	12	143.	47.9	3.2	1
UA776	FSC	1.00	12	79.	20.5	3.9	1
UA776	FSC	1.00	12	140.	31.5	4.5	1
UA776	FSC	1.00	12	274.	49.0	5.6	1
UA776	FSC	1.00	12	304.	36.0	8.5	1
UA776	FSC	0.10	12	1290.	90.0	14.5	1
UA776	FSC	0.10	12	2450.	150.0	16.5	1
UA776	FSC	10.00	2	55.	75.0	1.1	1
UA776	FSC	10.00	2	88.	27.9	3.2	1
UA776	FSC	10.00	2	77.	56.4	2.0	1
UA776	FSC	10.00	2	115.	37.3	3.1	1
UA776	FSC	10.00	-2	63.	20.8	3.0	1
UA776	FSC	10.00	-2	113.	36.1	3.3	1
UA776	FSC	10.00	-2	90.	25.0	3.6	1
UA776	FSC	10.00	-2	132.	36.0	3.8	1
UA776	FSC	1.00	-2	279.	45.2	6.2	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
UA776	FSC	1.00	-2	339.	47.2	7.2	1
UA776	FSC	1.00	-2	239.	40.5	5.9	1
UA776	FSC	1.00	-2	298.	44.8	6.7	1
UA776	FSC	0.10	-2	924.	88.0	10.5	1
UA776	FSC	0.10	-2	1344.	105.0	12.8	1
UA776	FSC	0.10	-2	788.	75.0	10.5	1
UA776	FSC	0.10	-2	1235.	95.0	13.0	1
UA776	FSC	0.10	12	1128.	60.0	18.8	1
UA776	FSC	0.10	12	1268.	65.0	19.5	1
UA776	FSC	1.00	-1	41.	83.0	0.5	1
UA776	FSC	1.00	-1	56.	82.5	0.7	1
UA776	FSC	1.00	-1	27.	75.0	0.4	1
UA776	FSC	1.00	-1	44.	85.0	0.5	1
UA776	FSC	10.00	-1	10.	149.0	0.1	1
UA776	FSC	10.00	-1	13.	162.0	0.1	1
UA776	FSC	10.00	-1	12.	150.0	0.1	1
UA776	FSC	10.00	-1	15.	171.0	0.1	1
MC1530G	MOT	10.00	1	148.	57.2	2.6	1
MC1530G	MOT	10.00	1	192.	61.7	3.2	1
MC1530G	MOT	10.00	1	154.	51.0	3.1	1
MC1530G	MOT	10.00	1	165.	49.2	3.4	1
MC1530G	MOT	10.00	-1	4.	24.0	0.2	1
MC1530G	MOT	10.00	-1	8.	17.0	0.5	1
MC1530G	MOT	10.00	-1	3.	24.0	0.1	1
MC1530G	MOT	10.00	-1	6.	21.3	0.4	1
MC1530G	MOT	1.00	-1	7.	28.0	0.3	1
MC1530G	MOT	1.00	-1	8.	30.0	0.3	1
MC1530G	MOT	1.00	-1	7.	22.5	0.3	1
MC1530G	MOT	1.00	-1	12.	30.6	0.4	1
MC1530G	MOT	0.10	-1	18.	45.0	0.4	1
MC1530G	MOT	0.10	-1	29.	56.0	0.5	1
MC1530G	MOT	10.00	2	146.	90.5	1.6	1
MC1530G	MOT	10.00	2	188.	85.3	2.2	1
MC1530G	MOT	10.00	2	121.	78.3	1.7	1
MC1530G	MOT	10.00	2	68.	20.8	3.6	1
MC1530G	MOT	10.00	-2	95.	14.0	6.8	1
MC1530G	MOT	10.00	-2	120.	15.0	3.0	1
MC1530G	MOT	10.00	-2	63	12.5	5.0	1
MC1530G	MOT	10.00	-2	82.	12.5	6.5	1
MC1530G	MOT	10.00	3	294.	75.6	4.0	1
MC1530G	MOT	10.00	3	371.	80.7	4.7	1
MC1530G	MOT	10.00	-3	79.	15.7	5.0	1
MC1530G	MOT	10.00	-3	109.	17.2	6.4	1
MC1530G	MOT	10.00	-3	86.	17.0	5.1	1
MC1530G	MOT	10.00	-3	99.	17.5	5.7	1
MC1530G	MOT	1.00	-3	173.	25.3	6.8	1
MC1530G	MOT	1.00	-3	220.	26.5	8.2	1
MC1530G	MOT	1.00	-3	120.	26.0	4.6	1
MC1530G	MOT	1.00	-3	157.	24.5	6.4	1
MC1530G	MOT	0.10	-3	165.	30.0	5.5	1
MC1530G	MOT	0.10	-3	312.	40.0	7.8	1
LM1031.	NSC	10.00	-3	18.	10.0	1.8	1

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DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
LM1031.	NSC	10.00	-3	21.	7.5	4.5	1
LM1031.	NSC	10.00	-3	20.	11.0	1.8	1
LM1031.	NSC	10.00	-3	19.	8.8	2.2	1
LM1031.	NSC	10.00	-3	16.	10.0	1.6	1
LM1031.	NSC	10.00	-3	22.	9.8	2.3	1
LM1031.	NSC	10.00	-3	18.	11.0	1.6	1
LM1031.	NSC	10.00	-3	19.	8.8	2.2	1
LM1031.	NSC	1.00	3	270.	15.0	18.0	1
LM1031.	NSC	1.00	3	378.	18.0	21.0	1
LM1031.	NSC	1.00	-3	73.	14.6	5.0	1
LM1031.	NSC	1.00	-3	83.	15.0	5.5	1
LM1031.	NSC	1.00	-3	28.	11.0	2.5	1
LM1031.	NSC	1.00	-3	56.	14.0	4.0	1
LM1031.	NSC	1.00	-3	34.	13.0	2.6	1
LM1031.	NSC	1.00	-3	55.	14.0	3.9	1
LM1031.	NSC	1.00	-3	56.	14.0	4.0	1
LM1031.	NSC	1.00	-3	63.	14.0	4.5	1
LM1031.	NSC	1.00	-3	28.	11.0	2.5	1
LM1031.	NSC	1.00	-3	49.	14.0	3.5	1
LM1035.	NSC	1.00	3	456.	24.0	19.0	1
LM1035.	NSC	1.00	3	594.	27.0	22.0	1
LM1035.	NSC	1.00	-3	26.	13.0	2.0	1
LM1035.	NSC	1.00	-3	43.	14.0	3.1	1
LM1035.	NSC	1.00	-3	26.	13.0	2.0	1
LM1035.	NSC	1.00	-3	42.	14.0	3.0	1
LM1035.	NSC	1.00	-3	39.	13.0	3.0	1
LM1035.	NSC	1.00	-3	57.	14.0	4.1	1
LM1035.	NSC	1.00	-3	39.	13.0	3.0	1
LM1035.	NSC	1.00	-3	59.	15.0	3.9	1
LM1035.	NSC	10.00	-3	22.	12.0	1.8	1
LM1035.	NSC	10.00	-3	27.	11.6	2.4	1
LM1035.	NSC	10.00	-3	20.	11.0	1.8	1
LM1035.	NSC	10.00	-3	22.	11.0	2.0	1
LM1035.	NSC	10.00	-3	19.	11.0	1.7	1
LM1035.	NSC	10.00	-3	22.	10.6	2.0	1
LM1035.	NSC	10.00	-3	20.	11.0	1.8	1
LM1035.	NSC	10.00	-3	21.	10.4	2.1	1
LM1035.	NSC	10.00	-3	19.	11.0	1.7	1
LM1035.	NSC	10.00	-3	20.	9.6	2.1	1
LM111H	NSC	1.00	5	-1.	-1.0	-1.0	1
LM111H	NSC	1.00	5	11.	11.0	1.0	1
LM111H	NSC	1.00	5	10.	49.8	0.3	1
LM111H	NSC	1.00	5	7.	22.0	0.3	1
LM111H	NSC	10.00	5	4.	18.3	0.2	1
LM111H	NSC	10.00	5	6.	23.5	0.3	1
LM111H	NSC	0.10	1	19.	92.0	0.3	1
LM111H	NSC	0.10	1	26.	110.4	0.3	1
LM111H	NSC	0.10	1	19.	101.4	0.3	1
LM111H	NSC	0.10	1	21.	91.8	0.3	1
LM111H	NSC	1.00	1	10.	34.0	0.3	1
LM111H	NSC	1.00	1	11.	34.0	0.3	1
LM111H	NSC	1.00	1	-1.	-1.0	-1.0	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
LM111H	NSC	1.00	1	11.	56.7	0.3	1
LM111H	NSC	10.00	1	6.	23.3	0.3	1
LM111H	NSC	10.00	1	6.	22.3	0.3	1
LM111H	NSC	10.00	2	130.	62.0	2.1	1
LM111H	NSC	10.00	2	119.	44.1	2.8	1
LM111H	NSC	10.00	2	113.	75.0	1.5	1
LM111H	NSC	10.00	2	73.	27.4	3.1	1
LM111H	NSC	1.00	2	171.	44.8	3.9	1
LM111H	NSC	1.00	2	243.	53.4	4.6	1
LM111H	NSC	1.00	2	135.	42.4	3.3	1
LM111H	NSC	1.00	2	163.	42.4	3.9	1
LM111H	NSC	1.00	3	180.	45.0	4.0	1
LM111H	NSC	1.00	3	338.	49.0	6.9	1
LM111H	NSC	1.00	3	152.	38.0	4.0	1
LM111H	NSC	1.00	3	276.	53.0	5.2	1
LM111H	NSC	10.00	3	7.	64.0	0.1	1
LM111H	NSC	10.00	3	8.	58.0	0.1	1
LM111H	NSC	10.00	3	5.	45.0	0.1	1
LM111H	NSC	10.00	3	7.	38.0	0.2	1
LM111H	NSC	10.00	3	6.	64.0	0.1	1
LM111H	NSC	10.00	3	8.	60.0	0.1	1
LM111H	NSC	10.00	3	32.	21.0	1.5	1
LM111H	NSC	10.00	3	77.	39.2	2.0	1
LM302	NSC	10.00	2	29.	15.0	1.9	1
LM302	NSC	10.00	2	55.	23.0	2.4	1
LM302	NSC	10.00	2	45.	18.0	2.5	1
LM302	NSC	10.00	2	57.	22.0	2.6	1
LM302	NSC	10.00	2	32.	18.0	1.8	1
LM302	NSC	10.00	2	42.	21.0	2.0	1
LM302	NSC	1.00	2	160.	32.0	5.0	1
LM302	NSC	1.00	2	204.	34.0	6.0	1
LM302	NSC	1.00	2	146.	28.0	5.2	1
LM302	NSC	1.00	2	186.	32.0	5.8	1
LM302	NSC	10.00	1	14.	12.0	1.2	1
LM302	NSC	10.00	1	42.	20.8	2.2	1
LM302	NSC	10.00	1	32.	16.5	2.0	1
LM302	NSC	10.00	1	59.	22.3	2.7	1
LM302	NSC	10.00	1	28.	14.2	2.0	1
LM302	NSC	10.00	1	74.	23.0	3.2	1
UA741	FSC	10.00	5	117.	52.5	2.2	1
UA741	FSC	10.00	5	166.	55.7	3.0	1
UA741	FSC	10.00	5	123.	50.5	2.5	1
UA741	FSC	10.00	5	175.	57.9	3.1	1
UA741	FSC	10.00	-5	12.	135.0	0.1	1
UA741	FSC	10.00	-5	13.	112.8	0.2	1
UA741	FSC	10.00	-5	20.	75.0	0.3	1
UA741	FSC	10.00	-5	16.	32.3	0.7	1
UA741	FSC	1.00	-5	25.	140.0	0.2	1
UA741	FSC	1.00	-5	98.	69.0	1.7	1
UA747	FSC	10.00	1	90.	46.1	2.0	1
UA747	FSC	10.00	1	122.	52.7	2.3	1
UA747	FSC	10.00	1	71.	34.0	2.1	1

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
UA747	FSC	10.00	1	105.	51.0	2.1	1
UA747	FSC	10.00	1	76.	48.8	1.6	1
UA747	FSC	10.00	1	100.	50.4	2.0	1
UA747	FSC	10.00	1	90.	53.0	1.7	1
UA747	FSC	10.00	1	107.	52.4	2.0	1
UA747	FSC	10.00	1	81.	48.4	1.8	1
UA747	FSC	10.00	1	112.	54.3	2.1	1
UA747	FSC	1.00	1	234.	90.0	2.6	1
UA747	FSC	1.00	1	408.	114.0	3.6	1
UA747	FSC	1.00	1	200.	80.0	2.5	1
UA747	FSC	1.00	1	151.	52.5	3.8	1
UA747	FSC	1.00	1	264.	88.0	3.0	1
UA747	FSC	1.00	1	336.	96.0	3.5	1
UA747	FSC	1.00	1	326.	93.0	3.5	1
UA747	FSC	1.00	1	462.	110.0	4.2	1
UA747	FSC	1.00	1	238.	85.0	2.8	1
UA747	FSC	1.00	1	357.	105.0	3.4	1
UA747	FSC	10.00	1	72.	43.0	1.7	1
UA747	FSC	10.00	1	145.	55.9	2.6	1
UA747	FSC	1.00	1	229.	88.0	2.6	1
UA747	FSC	1.00	1	360.	80.0	4.5	1
UA747	FSC	1.00	1	180.	75.0	2.4	1
UA747	FSC	1.00	1	323.	95.0	3.4	1
UA747	FSC	1.00	1	320.	100.0	3.2	1
UA747	FSC	1.00	1	399.	105.0	3.8	1
UA747	FSC	1.00	1	214.	90.0	2.4	1
UA747	FSC	1.00	1	333.	87.0	3.9	1
UA747	FSC	1.00	1	201.	83.0	2.5	1
UA747	FSC	1.00	1	334.	102.0	3.3	1
UA747	FSC	10.00	5	86.	44.5	2.0	1
UA747	FSC	10.00	5	127.	53.9	2.4	1
UA747	FSC	10.00	5	102.	52.5	2.0	1
UA747	FSC	10.00	5	125.	51.3	2.5	1
UA747	FSC	10.00	5	107.	52.5	2.1	1
UA747	FSC	10.00	5	132.	57.2	2.3	1
UA747	FSC	10.00	5	120.	48.0	2.5	1
UA747	FSC	10.00	5	167.	50.6	3.3	1
UA747	FSC	1.00	5	64.	53.6	1.6	1
UA747	FSC	1.00	5	133.	63.8	2.3	1
UA747	FSC	1.00	5	235.	68.0	3.7	1
UA747	FSC	1.00	5	339.	89.5	3.8	1
UA747	FSC	1.00	5	255.	89.5	2.9	1
UA747	FSC	1.00	5	292.	74.5	4.0	1
UA747	FSC	1.00	5	82.	75.6	1.4	1
UA747	FSC	1.00	5	164.	74.7	2.3	1
UA747	FSC	10.00	2	78.	24.5	3.2	1
UA747	FSC	10.00	2	145.	39.6	3.8	1
UA747	FSC	10.00	2	64.	19.5	3.3	1
UA747	FSC	10.00	2	92.	28.8	3.4	1
UA747	FSC	10.00	2	84.	24.6	3.4	1
UA747	FSC	10.00	2	126.	38.9	3.4	1
UA747	FSC	10.00	2	61.	20.0	3.1	1

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
UA747	FSC	10.00	2	101.	33.4	3.2	1
N5710T	SIC	10.00	6	16.	48.0	0.3	1
N5710T	SIC	10.00	6	30.	48.5	0.6	1
N5710T	SIC	10.00	6	19.	59.0	0.3	1
N5710T	SIC	10.00	6	30.	54.3	0.6	1
N5710T	SIC	1.00	6	111.	73.3	1.5	1
N5710T	SIC	1.00	6	153.	74.1	2.2	1
N5710T	SIC	1.00	6	112.	77.0	1.5	1
N5710T	SIC	1.00	6	135.	70.3	2.0	1
N5710T	SIC	10.00	2	33.	37.0	0.9	1
N5710T	SIC	10.00	2	61.	39.7	1.5	1
N5710T	SIC	10.00	2	36.	37.6	1.0	1
N5710T	SIC	10.00	2	70.	43.8	1.6	1
N5710T	SIC	1.00	2	94.	57.5	1.7	1
N5710T	SIC	1.00	2	126.	64.0	2.0	1
N5710T	SIC	1.00	2	95.	57.5	1.7	1
N5710T	SIC	1.00	2	136.	66.0	2.1	1
SN75107	TIX	10.00	-1	7.	7.6	0.9	1
SN75107	TIX	10.00	-1	16.	15.5	1.0	1
SN75107	TIX	10.00	-1	11.	16.0	0.7	1
SN75107	TIX	10.00	-1	14.	17.0	0.9	1
SN75107	TIX	10.00	1	9.	19.7	0.5	1
SN75107	TIX	10.00	1	11.	13.6	0.9	1
SN75107	TIX	10.00	1	13.	23.7	0.5	1
SN75107	TIX	10.00	1	10.	15.6	0.8	1
SN75107	TIX	1.00	1	40.	36.9	1.1	1
SN75107	TIX	1.00	1	39.	29.1	1.5	1
SN75107	TIX	1.00	1	39.	28.6	1.5	1
SN75107	TIX	1.00	1	31.	19.3	1.8	1
SN75107	TIX	0.10	1	177.	68.0	2.6	1
SN75107	TIX	0.10	1	210.	75.0	2.8	1
SN75107	TIX	0.10	1	208.	80.0	2.6	1
SN75107	TIX	0.10	1	247.	85.0	2.9	1
SN75107	TIX	1.00	1	24.	20.4	1.3	1
SN75107	TIX	1.00	1	38.	24.0	1.6	1
710	B	0.10	-1	17.	49.0	0.4	9
710	B	0.10	1	23.	49.0	0.4	9
710	B	1.00	1	5.	27.0	0.2	9
710	B	1.00	1	7.	27.0	0.2	9
710	B	10.00	1	2.	17.5	0.1	9
710	B	10.00	1	2.	17.5	0.1	9
710	C	0.10	1	16.	38.0	0.6	9
710	C	0.10	1	23.	38.0	0.6	9
710	C	1.00	1	4.	22.5	0.2	9
710	C	1.00	1	7.	22.5	0.2	9
710	C	10.00	1	3.	22.0	0.2	9
710	C	10.00	-1	4.	22.0	0.2	9
UA709	FSC	0.10	11	50.	-1.0	-1.0	6
UA709	FSC	0.15	11	26.	-1.0	-1.0	6
UA709	FSC	0.20	11	28.	-1.0	-1.0	6
UA709	FSC	0.10	11	23.	-1.0	-1.0	6
UA709	FSC	0.16	11	28.	-1.0	-1.0	6

APPENDIX A

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
UA709	FSC	0.13	11	40.	-1.0	-1.0	6
UA709	FSC	0.10	11	24.	-1.0	-1.0	6
UA709	FSC	0.20	11	26.	-1.0	-1.0	6
UA709	FSC	0.11	-3	33.	-1.0	-1.0	6
UA709	FSC	0.12	-3	36.	-1.0	-1.0	6
UA709	FSC	0.80	2	49.	-1.0	-1.0	6
UA709	FSC	1.00	2	46.	-1.0	-1.0	6
UA709	FSC	3.00	2	44.	-1.0	-1.0	6
UA709	FSC	0.40	2	72.	-1.0	-1.0	6
UA709	FSC	0.70	2	59.	-1.0	-1.0	6
UA709	FSC	0.70	2	58.	-1.0	-1.0	6
MC1530G	MOT	0.10	1	2080.	520.0	4.0	3
MC1530G	MOT	1.00	1	280.	145.0	2.0	3
MC1530G	MOT	10.00	1	48.	30.0	1.6	3
MC1530G	MOT	0.10	2	4650.	580.0	8.0	3
MC1530G	MOT	1.00	2	2200.	480.0	4.6	3
MC1530G	MOT	10.00	2	37.	28.0	1.3	3
MC1530G	MOT	0.90	3	4000.	580.0	7.0	3
MC1530G	MOT	1.00	3	1675.	380.0	4.4	3
MC1530G	MOT	10.00	3	320.	160.0	2.0	3
709R	RAD	0.10	1	310.	240.0	1.2	3
709R	RAD	1.00	1	15.	100.0	0.2	3
709R	RAD	10.00	1	4.	67.0	0.1	3
709R	RAD	0.10	2	190.	190.0	1.0	3
709R	RAD	1.00	2	18.	65.0	0.3	3
709R	RAD	10.00	2	9.	45.0	0.2	3
709R	RAD	0.10	3	350.	290.0	1.2	3
709R	RAD	1.00	3	67.	240.0	0.3	3
709R	RAD	10.00	3	16.	195.0	0.1	3
SN72709	TIX	0.10	1	1580.	210.0	7.5	3
SN72709	TIX	1.00	1	505.	140.0	3.6	3
SN72709	TIX	10.00	1	78.	43.0	1.8	3
SN72709	TIX	0.15	2	5600.	560.0	10.0	3
SN72709	TIX	1.00	2	3600.	450.0	8.0	3
SN72709	TIX	10.00	2	2500.	420.0	6.0	3
SN72709	TIX	0.19	3	4500.	450.0	10.0	3
SN72709	TIX	1.00	3	2660.	380.0	7.0	3
SN72709	TIX	10.00	3	720.	180.0	4.0	3
1752	BUB	1.50	1	1702.	460.0	3.7	6
1752	BUB	2.00	1	-1.	-1.0	-1.0	6
1752	BUB	0.40	1	690.	230.0	3.0	6
1752	BUB	2.00	1	-1.	-1.0	-1.0	6
RA239	RAD	0.10	2	160.	160.0	1.0	7
RA239	RAD	0.10	2	352.	[illegible]20.0	1.6	7
RA239	RAD	0.09	-1	83.	150.0	0.6	7
RA239	RAD	0.09	-1	152.	190.0	0.8	7
[illegible]39	RAD	0.13	3	210.	300.0	0.7	7
R[illegible]239	RAD	0.13	3	400.	400.0	1.0	7
RA239	RAD	0.10	-3	-1.	-1.0	-1.0	7
RA239	RAD	0.13	-3	-1.	-1.0	-1.0	7

APPENDIX B.--INTEGRATED CIRCUIT PULSE DAMAGE DATA

The detailed pulse damage data for each integrated circuit type that was tested during this program is tabulated in this appendix. In addition, the results of another internal program are also included here. The table headings are the same as Appendix A. The order of devices is as follows.

74S112
SN74S00
54LS27
54LS74
74LS00
74L112
74L122
SN74L00
SN74L04
LM301A
LM308
LM311
LM339

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
74S112	TIX	0.10	1	792.	49.7	16.2	13
74S112	TIX	0.10	1	2070.	71.7	25.4	13
74S112	TIX	0.10	1	3678.	90.2	37.5	13
74S112	TIX	0.10	2	93.	15.4	5.8	13
74S112	TIX	0.10	2	187.	25.2	8.2	13
74S112	TIX	0.10	2	95.	15.9	5.9	13
74S112	TIX	0.10	2	178.	25.0	8.1	13
74S112	TIX	0.10	3	576.	42.5	12.5	13
74S112	TIX	0.10	3			25.6	13
74S112	TIX	0.10	3	1912.	66.8	26.0	13
74S112	TIX	0.10	3	3427.	84.1	37.5	13
74S112	TIX	0.10	-3	5282.	94.4	53.5	13
74S112	TIX	0.10	-3	10481.	136.5	72.7	13
74S112	TIX	0.10	-3	5117.	91.1	52.9	13
74S112	TIX	0.10	-3	10840.	134.0	77.3	13
74S112	TIX	0.10	-2	136.	16.7	8.3	13
74S112	TIX	0.10	-2	198.	13.8	11.4	13
74S112	TIX	0.10	-2	129.	15.9	8.0	13
74S112	TIX	0.10	-2	320.	28.5	11.5	13
74S112	TIX	0.10	-1	1531.	58.3	25.0	13
74S112	TIX	0.10	-1	4039.	100.2	37.2	13
74S112	TIX	0.10	-1	1685.	62.5	25.5	13
74S112	TIX	0.10	-1	3822.	100.1	37.2	13
74S112	TIX	0.01	1	3014.	137.0	22.0	13
74S112	TIX	0.01	1	8498.	239.9	35.3	13
74S112	TIX	0.01	1	10487.	282.6	40.4	13
74S112	TIX	0.01	1	19100.	335.5	55.3	13
74S112	TIX	0.01	2	1152.	72.0	16.4	13
74S112	TIX	0.01	2	2197.	116.9	20.3	13
74S112	TIX	0.01	2	1150.	70.0	16.5	13
74S112	TIX	0.01	2	1905.	112.6	20.4	13
74S112	TIX	0.01	3	6376.	224.8	31.2	13
74S112	TIX	0.01	3	4497.	175.7	27.0	13
74S112	TIX	0.01	3	5556.	213.4	30.3	13
74S112	TIX	0.01	3	4377.	175.0	26.1	13
74S112	TIX	0.01	3	5539.	237.4	28.4	13
74S112	TIX	0.01	-3	44000.	401.0	110.0	13
74S112	TIX	0.01	-3	82228.	578.1	134.7	13
74S112	TIX	0.01	-3	17619.	312.7	56.6	13
74S112	TIX	0.01	-3	35964.	309.0	98.2	13
74S112	TIX	0.01	-2	1245.	75.0	16.6	13
74S112	TIX	0.01	-2	1995.	108.7	18.7	13
74S112	TIX	0.01	-2	1561.	97.2	19.0	13
74S112	TIX	0.01	-2	2918.	134.8	25.1	13
74S112	TIX	0.01	-1	14410.	307.5	48.5	13
74S112	TIX	0.01	-1	25522.	387.0	66.4	13
74S112	TIX	0.01	-1	11536.	283.5	37.6	13
74S112	TIX	0.01	-1	27600.	300.0	97.0	13
SN74S00	TIX	0.10	1	111.	27.6	3.7	13
SN74S00	TIX	0.10	1	136.	15.7	7.8	13
SN74S00	TIX	0.10	2	36.	18.5	1.8	13
SN74S00	TIX	0.10	2	51.	17.3	2.7	13

DEVICE	MFG	TIME	PIN	PWR	VAVC	IAVG	SOD
SN74S00	TIX	0.10	2	33.	16.4	1.8	13
SN74S00	TIX	0.10	2	39.	12.1	2.8	13
SN74S00	TIX	0.10	3	1620.	62.9	23.2	13
SN74S00	TIX	0.10	3	3037.	79.7	36.2	13
SN74S00	TIX	0.10	3	1593.	62.4	23.1	13
SN74S00	TIX	0.10	3	2879.	75.9	36.0	13
SN74S00	TIX	0.10	-3	1713.	61.9	25.1	13
SN74S00	TIX	0.10	-3	2669.	69.6	35.5	13
SN74S00	TIX	0.10	-3	1632.	63.0	23.8	13
SN74S00	TIX	0.10	-3	2861.	72.7	36.8	13
SN74S00	TIX	0.10	-2	631.	39.9	14.3	13
SN74S00	TIX	0.10	-2	242.	23.2	10.5	13
SN74S00	TIX	0.10	-2	455.	36.9	10.9	13
SN74S00	TIX	0.10	-1	403.	25.0	16.1	13
SN74S00	TIX	0.10	-1	917.	31.4	25.6	13
SN74S00	TIX	0.10	-1	937.	29.6	28.0	13
SN74S00	TIX	0.10	-1	1971.	46.7	40.6	13
SN74S00	TIX	0.01	1	2600.	100.0	26.0	13
SN74S00	TIX	0.01	1	3165.	118.3	28.0	13
SN74S00	TIX	0.01	1	5987.	192.2	49.3	13
SN74S00	TIX	0.01	1	16667.	220.8	67.9	13
SN74S00	TIX	0.01	2	1260.	74.0	17.0	13
SN74S00	TIX	0.01	2	3125.	125.0	25.0	13
SN74S00	TIX	0.01	2	1530.	85.4	18.0	13
SN74S00	TIX	0.01	2	6052.	178.0	34.0	13
SN74S00	TIX	0.01	3	23870.	341.0	70.0	13
SN74S00	TIX	0.01	3	37500.	375.0	100.0	13
SN74S00	TIX	0.01	3	27188.	364.5	66.6	13
SN74S00	TIX	0.01	3	33376.	516.9	85.2	13
SN74S00	TIX	0.01	-3	29360.	367.0	80.0	13
SN74S00	TIX	0.01	-3	54450.	495.0	110.0	13
SN74S00	TIX	0.01	-3	32600.	326.0	100.0	13
SN74S00	TIX	0.01	-3	78910.	607.0	130.0	13
SN74S00	TIX	0.01	-2	1207.	71.0	17.0	13
SN74S00	TIX	0.01	-2	3755.	161.0	26.1	13
SN74S00	TIX	0.01	-2	1775.	100.3	18.2	13
SN74S00	TIX	0.01	-2	2776.	128.3	23.2	13
SN74S00	TIX	0.01	-1	15736.	259.1	62.3	13
SN74S00	TIX	0.01	-1	26989.	251.6	103.1	13
SN74S00	TIX	0.01	-1	38664.	261.7	103.3	13
54LS27	TIX	0.30	1	45.	15.4	2.7	14
54LS27	TIX	0.30	1	48.	11.6	4.0	14
54LS27	TIX	0.30	1	77.	13.0	5.7	14
54LS27	TIX	0.30	1	228.	31.3	8.0	14
54LS27	TIX	0.30	2	82.	13.8	5.7	14
54LS27	TIX	0.30	2	129.	14.7	8.0	14
54LS27	TIX	0.30	2	84.	13.9	5.9	14
54LS27	TIX	0.30	2	131.	14.4	8.3	14
54LS27	TIX	0.30	-2	39.	9.3	4.1	14
54LS27	TIX	0.30	-2	54.	9.0	5.8	14
54LS27	TIX	0.30	-2	37.	8.9	4.0	14
54LS27	TIX	0.30	-2	56.	9.2	5.8	14

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
54LS27	TIX	0.30	-1				
54LS27	TIX	0.30	-1	79.	13.6	5.8	14
54LS27	TIX	0.30	-1	72.	12.6	5.8	14
54LS27	TIX	0.30	-1	288.	35.7	7.9	14
54LS27	TIX	0.03	1	941.	58.2	14.8	14
54LS27	TIX	0.03	1	1943.	84.4	20.2	14
54LS27	TIX	0.03	1	785.	47.1	15.7	14
54LS27	TIX	0.03	1	1475.	74.6	21.0	14
54LS27	TIX	0.03	2	467.	37.2	11.9	14
54LS27	TIX	0.03	2	819.	45.8	16.1	14
54LS27	TIX	0.03	2	498.	38.3	12.3	14
54LS27	TIX	0.03	2	813.	44.7	16.4	14
54LS27	TIX	0.03	-2	312.	23.1	12.3	14
54LS27	TIX	0.03	-2	547.	31.6	16.1	14
54LS27	TIX	0.03	-2	1247.	48.0	23.8	14
54LS27	TIX	0.03	-1	731.	41.7	17.1	14
54LS27	TIX	0.03	-1	2425.	93.6	24.3	14
54LS27	TIX	0.03	-1	739.	44.9	15.8	14
54LS27	TIX	0.03	-1	1235.	64.8	20.0	14
54LS74	TIX	0.30	1	68.	11.3	5.8	14
54LS74	TIX	0.30	1	123.	14.0	8.0	14
54LS74	TIX	0.30	1	26.	6.1	4.0	14
54LS74	TIX	0.30	2	104.	17.0	5.8	14
54LS74	TIX	0.30	2	168.	18.2	8.2	14
54LS74	TIX	0.30	2	68.	15.4	4.1	14
54LS74	TIX	0.30	2	106.	16.1	5.8	14
54LS74	TIX	0.30	-2	73.	12.2	5.8	14
54LS74	TIX	0.30	-2	109.	13.1	8.0	14
54LS74	TIX	0.30	-2	71.	11.8	5.8	14
54LS74	TIX	0.30	-2	112.	13.3	8.1	14
54LS74	TIX	0.30	-1	109.	13.6	7.9	14
54LS74	TIX	0.30	-1	202.	16.5	11.5	14
54LS74	TIX	0.30	-1	137.	16.6	8.1	14
54LS74	TIX	0.30	-1	219.	18.0	11.1	14
54LS74	TIX	0.03	1	1187.	45.6	23.7	14
54LS74	TIX	0.03	1	1867.	53.2	32.3	14
54LS74	TIX	0.03	1	2115.	57.0	35.0	14
54LS74	TIX	0.03	1	8000.	124.0	64.5	14
54LS74	TIX	0.03	2	836.	49.0	16.3	14
54LS74	TIX	0.03	2	1809.	63.4	24.2	14
54LS74	TIX	0.03	2	912.	54.7	15.6	14
54LS74	TIX	0.03	2	1842.	63.1	25.2	14
54LS74	TIX	0.03	-2	1200.	45.8	24.1	14
54LS74	TIX	0.03	-2	502.	30.4	15.4	14
54LS74	TIX	0.03	-2	1320.	49.3	24.6	14
54LS74	TIX	0.03	-1	4254.	82.7	50.7	14
54LS74	TIX	0.03	-1	9403.	163.7	60.3	14
54LS74	TIX	0.03	-1	2168.	58.1	33.4	14
54LS74	TIX	0.03	-1	3604.	73.8	48.9	14
74LS00	TIX	1.00	1	42.	9.2	4.2	13
74LS00	TIX	1.00	1	60.	11.1	5.2	13
74LS00	TIX	1.00	1	41.	9.1	4.0	13

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
74LS00	TIX	1.00	1	72.	11.6	5.8	13
74LS00	TIX	1.00	2	10.	7.3	1.2	13
74LS00	TIX	1.00	2	14.	6.2	1.9	13
74LS00	TIX	1.00	2	13.	6.7	1.9	13
74LS00	TIX	1.00	2	19.	5.9	2.8	13
74LS00	TIX	1.00	3	202.	33.7	5.8	13
74LS00	TIX	1.00	3	337.	38.4	8.0	13
74LS00	TIX	1.00	3	159.	27.5	5.8	13
74LS00	TIX	1.00	3	369.	44.0	8.3	13
74LS00	TIX	1.00	-3	86.	15.4	5.7	13
74LS00	TIX	1.00	-3	104.	25.0	4.0	13
74LS00	TIX	1.00	-3	41.	9.9	4.1	13
74LS00	TIX	1.00	-3	91.	17.2	5.7	13
74LS00	TIX	1.00	-2	19.	6.9	2.7	13
74LS00	TIX	1.00	-2	36.	8.5	4.1	13
74LS00	TIX	1.00	-2	20.	6.9	2.7	13
74LS00	TIX	1.00	-2	27.	6.2	4.1	13
74LS00	TIX	1.00	-1	61.	10.1	5.6	13
74LS00	TIX	1.00	-1	113.	13.4	8.2	13
74LS00	TIX	1.00	-1	62.	10.5	5.8	13
74LS00	TIX	1.00	-1	128.	14.7	8.4	13
74LS00	TIX	0.30	1	43.	9.8	4.0	14
74LS00	TIX	0.30	1	66.	10.8	5.9	14
74LS00	TIX	0.30	1	39.	9.0	3.9	14
74LS00	TIX	0.30	1	55.	9.1	5.8	14
74LS00	TIX	0.30	2	59.	13.9	4.0	14
74LS00	TIX	0.30	2	102.	16.1	5.8	14
74LS00	TIX	0.30	2	58.	13.7	4.0	14
74LS00	TIX	0.30	2	108.	16.8	5.8	14
74LS00	TIX	0.30	-2	47.	11.5	4.0	14
74LS00	TIX	0.30	-2	77.	12.9	5.8	14
74LS00	TIX	0.30	-2	51.	11.9	4.0	14
74LS00	TIX	0.30	-2	85.	14.1	5.9	14
74LS00	TIX	0.30	-1			8.0	14
74LS00	TIX	0.30	-1	453.	40.3	11.1	14
74LS00	TIX	0.30	-1	155.	19.3	7.8	14
74LS00	TIX	0.30	-1	336.	33.6	11.3	14
74LS00	TIX	0.10	1	369.	30.5	11.2	13
74LS00	TIX	0.10	1				13
74LS00	TIX	0.10	1	131.	15.3	8.0	13
74LS00	TIX	0.10	1	454.	38.8	11.4	13
74LS00	TIX	0.10	1	380.	42.1	10.9	13
74LS00	TIX	0.10	2	150.	19.7	7.4	13
74LS00	TIX	0.10	2	250.	20.2	10.9	13
74LS00	TIX	0.10	2	314.	23.7	11.1	13
74LS00	TIX	0.10	2	342.	19.6	15.3	13
74LS00	TIX	0.10	3	489.	41.6	11.0	13
74LS00	TIX	0.10	3	1088.	68.0	16.0	13
74LS00	TIX	0.10	3	3289.	97.6	31.5	13
74LS00	TIX	0.10	-3	2912.	72.7	36.7	13
74LS00	TIX	0.10	-3	5874.	110.2	51.5	13
74LS00	TIX	0.10	-3	562.	35.9	15.6	13

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
74LS00	TIX	0.10	-2	32.	8.0	3.8	13
74LS00	TIX	0.10	-2	55.	9.3	5.6	13
74LS00	TIX	0.10	-2	55.	9.8	5.4	13
74LS00	TIX	0.10	-1	524.	31.0	14.9	13
74LS00	TIX	0.10	-1	1977.	54.3	30.8	13
74LS00	TIX	0.10	-1	481.	29.7	14.5	13
74LS00	TIX	0.03	1	716.	50.5	12.3	13
74LS00	TIX	0.03	1	1568.	61.6	25.3	13
74LS00	TIX	0.03	1	1327.	50.8	23.9	13
74LS00	TIX	0.03	1	2147.	73.2	28.6	13
74LS00	TIX	0.03	2	549.	46.8	11.0	13
74LS00	TIX	0.03	2	1048.	60.6	16.2	13
74LS00	TIX	0.03	2	1027.	60.8	16.0	13
74LS00	TIX	0.03	2	1982.	74.1	23.4	13
74LS00	TIX	0.03	-2	457.	33.6	12.6	13
74LS00	TIX	0.03	-2	130.	19.3	6.3	13
74LS00	TIX	0.03	-2	197.	22.3	8.1	13
74LS00	TIX	0.03	-1	1495.	56.8	23.9	13
74LS00	TIX	0.03	-1	2608.	86.4	31.4	13
74LS00	TIX	0.03	-1	1647.	61.3	24.7	13
74LS00	TIX	0.03	-1	3124.	92.3	32.9	13
74LS00	TIX	0.01	1	11022.	250.5	51.3	13
74LS00	TIX	0.01	1	13032.	291.4	57.7	13
74LS00	TIX	0.01	1	10880.	253.4	50.7	13
74LS00	TIX	0.01	1	17958.	305.7	60.7	13
74LS00	TIX	0.01	2	6805.	189.0	37.7	13
74LS00	TIX	0.01	2	2035.	110.0	18.5	13
74LS00	TIX	0.01	2	3438.	133.8	22.6	13
74LS00	TIX	0.01	3	1571.	125.7	12.4	13
74LS00	TIX	0.01	3	458.	84.9	5.6	13
74LS00	TIX	0.01	3	793.	103.5	7.9	13
74LS00	TIX	0.01	-3	4767.	177.0	24.0	13
74LS00	TIX	0.01	-3	19141.	353.1	49.5	13
74LS00	TIX	0.01	-3	4573.	180.7	26.4	13
74LS00	TIX	0.01	-3	8115.	231.4	31.0	13
74LS00	TIX	0.01	-2	1739.	96.9	18.7	13
74LS00	TIX	0.01	-2	417.	52.9	9.0	13
74LS00	TIX	0.01	-2	639.	65.3	11.1	13
74LS00	TIX	0.01	-1	3281.	119.7	24.6	13
74LS00	TIX	0.01	-1	9250.	212.7	43.3	13
74LS00	TIX	0.01	-1	5739.	198.7	35.2	13
74LS00	TIX	0.01	-1	9989.	241.4	48.0	13
74LS112	TIX	1.00	1	98.	41.0	2.3	13
74LS112	TIX	1.00	1	232.	60.5	3.6	13
74LS112	TIX	1.00	1	204.	47.0	4.0	13
74LS112	TIX	1.00	1	588.	102.8	5.5	13
74LS112	TIX	1.00	2	57.	24.0	2.3	13
74LS112	TIX	1.00	2	142.	36.2	3.9	13
74LS112	TIX	1.00	2	61.	24.5	2.4	13
74LS112	TIX	1.00	3	269.	63.6	4.0	13
74LS112	TIX	1.00	3	538.	104.8	5.5	13
74LS112	TIX	1.00	3	219.	54.4	4.0	13

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
74LS112	TIX	1.00	3	447.	89.6	5.5	13
74LS112	TIX	1.00	-3	78.	20.1	4.1	13
74LS112	TIX	1.00	-3	268.	61.9	5.7	13
74LS112	TIX	1.00	-3	74.	18.9	4.1	13
74LS112	TIX	1.00	-3	245.	57.5	5.6	13
74LS112	TIX	1.00	-2	114.	31.0	4.1	13
74LS112	TIX	1.00	-2	256.	43.7	5.6	13
74LS112	TIX	1.00	-2	103.	26.4	4.0	13
74LS112	TIX	1.00	-2	301.	57.8	5.6	13
74LS112	TIX	1.00	-1	331.	81.2	3.8	13
74LS112	TIX	1.00	-1	422.	77.8	5.5	13
74LS112	TIX	1.00	-1	196.	47.6	3.9	13
74LS112	TIX	1.00	-1	357.	66.3	5.5	13
74LS112	TIX	0.10	1	2066.	221.0	10.0	13
74LS112	TIX	0.10	1	832.	105.9	7.5	13
74LS112	TIX	0.10	1	1373.	115.7	11.0	13
74LS112	TIX	0.10	1	2538.	153.6	15.3	13
74LS112	TIX	0.10	2	471.	57.9	7.5	13
74LS112	TIX	0.10	2	987.	86.1	10.9	13
74LS112	TIX	0.10	2	465.	56.8	7.7	13
74LS112	TIX	0.10	2	901.	76.7	11.1	13
74LS112	TIX	0.10	3	1692.	110.7	15.7	13
74LS112	TIX	0.10	3	6936.	251.0	24.5	13
74LS112	TIX	0.10	3	1071.	87.5	11.3	13
74LS112	TIX	0.10	3	1955.	143.4	14.8	13
74LS112	TIX	0.10	-3	1214.	90.3	15.2	13
74LS112	TIX	0.10	-3	-179.	-6.3	22.8	13
74LS112	TIX	0.10	-3	1403.	103.2	15.5	13
74LS112	TIX	0.10	-3	5681.	[illegible]4.4	24.0	13
74LS112	TIX	0.10	-2	291.	36.7	7.6	13
74LS112	TIX	0.10	-2	625.	57.8	11.0	13
74LS112	TIX	0.10	-2	566.	56.0	10.1	13
74LS112	TIX	0.10	-2	1524.	88.9	15.1	13
74LS112	TIX	0.10	-1	2521.	162.7	14.6	13
74LS112	TIX	0.10	-1	5684.	233.7	21.9	13
74LS112	TIX	0.10	-1	2639.	161.2	15.4	13
74LS112	TIX	0.10	-1	5463.	217.9	22.8	13
74LS112	TIX	0.01	1	19405.	507.8	37.6	13
74LS112	TIX	0.01	1	39697.	772.4	52.1	13
74LS112	TIX	0.01	1	21285.	543.4	38.2	13
74LS112	TIX	0.01	1	30752.	624.1	48.3	13
74LS112	TIX	0.01	1	10280.	455.0	24.1	13
74LS112	TIX	0.01	1	33918.	666.5	53.0	13
74LS112	TIX	0.01	2	6912.	261.7	26.0	13
74LS112	TIX	0.01	2	13691.	406.5	37.0	13
74LS112	TIX	0.01	2	4224.	192.0	22.0	13
74LS112	TIX	0.01	2	6693.	252.8	25.8	13
74LS112	TIX	0.01	3	12555.	279.0	45.0	13
74LS112	TIX	0.01	3	29390.	629.2	50.3	13
74LS112	TIX	0.01	3	15200.	400.0	38.3	13
74LS112	TIX	0.01	3	34903.	636.5	53.9	13
74LS112	TIX	0.01	-3	11125.	324.5	36.4	13

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
74LS112	TIX	0.01	-3	29023.	610.2	51.2	13
74LS112	TIX	0.01	-3	7315.	209.0	35.0	13
74LS112	TIX	0.01	-3	10000.	250.0	40.0	13
74LS112	TIX	0.01	-2	1385.	110.9	13.0	13
74LS112	TIX	0.01	-2	2742.	163.7	18.8	13
74LS112	TIX	0.01	-2	3288.	171.6	19.2	13
74LS112	TIX	0.01	-1	11762.	369.0	31.2	13
74LS112	TIX	0.01	-1	14550.	291.0	50.0	13
74LS112	TIX	0.01	-1	8089.	297.8	25.9	13
74LS112	TIX	0.01	-1	14974.	426.1	38.1	13
74L122	TIX	0.10	3	5157.	194.5	24.2	13
74L122	TIX	0.10	3	8393.	210.0	35.7	13
74L122	TIX	0.10	3	2034.	136.5	13.1	13
74L122	TIX	0.10	-3	538.	65.3	7.6	13
74L122	TIX	0.10	-3	1612.	105.4	14.3	13
74L122	TIX	0.10	-3	2660.	105.7	24.4	13
74L122	TIX	0.10	-3	5699.	153.7	37.1	13
74L122	TIX	0.10	-2	[illegible]139.	98.6	36.7	13
74L122	TIX	0.10	-2	5183.	89.8	50.0	13
74L122	TIX	0.10	-2	5693.	99.7	49.7	13
74L122	TIX	0.10	-2	8902.	106.9	72.4	13
74L122	TIX	0.10	-2				
74L122	TIX	0.10	-2	2377.	89.1	26.1	13
74L122	TIX	0.01	1	5050.	202.0	25.0	13
74L122	TIX	0.01	1	6300.	225.0	28.0	13
74L122	TIX	0.01	1	2400.	149.0	16.0	13
74L122	TIX	0.01	1				
74L122	TIX	0.01	3	21014.	431.5	49.1	13
74L122	TIX	0.01	3	25171.	510.2	56.7	13
74L122	TIX	0.01	3	17550.	390.0	45.0	13
74L122	TIX	0.01	3	25065.	473.8	54.0	13
74L122	TIX	0.01	-2	15625.	322.5	55.6	13
74L122	TIX	0.01	-2	28092.	428.1	57.1	13
74L122	TIX	0.01	-2	44121.	436.7	97.5	13
74L122	TIX	0.01	-2	66914.	552.8	135.8	13
74L122	TIX	0.01	-2	32758.	451.9	69.3	13
74L122	TIX	0.01	-2	31280.	391.0	80.0	13
74L122	TIX	0.01	-2	41000.	585.0	58.3	13
74L122	TIX	0.01	-2	72720.	823.7	79.7	13
74L122	TIX	0.01	-1	8000.	200.0	40.0	13
74L122	TIX	0.01	-1	4000.	100.0	40.0	13
74L122	TIX	0.01	-1	2710.	110.8	26.0	13
74L122	TIX	0.01	-1	8093.	261.5	28.9	13
74L122	TIX		1			8.6	13
SN74L00	TIX	0.10	-3	1283.	43.2	26.1	13
SN74L00	TIX	0.10	-3	2123.	54.5	37.2	13
SN74L00	TIX	0.10	-3	1358.	47.1	26.3	13
SN74L00	TIX	0.10	-3	2718.	69.6	37.3	13
SN74L00	TIX	0.10	-2	101.	17.6	5.3	13
SN74L00	TIX	0.10	-2	186.	23.2	7.9	13
SN74L00	TIX	0.10	-2	81.	9.7	10.7	13
SN74L00	TIX	0.01	1	12593.	302.0	41.7	13

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74L00	TIX	0.01	1	16494.	322.6	64.5	13
SN74L00	TIX	0.01	1	14315.	375.7	38.3	13
SN74L00	TIX	0.01	1	16875.	375.0	45.0	13
SN74L00	TIX	0.01	-3	20279.	342.5	59.1	13
SN74L00	TIX	0.01	-3	39174.	474.8	87.4	13
SN74L00	TIX	0.01	-3	13295.	304.1	51.3	13
SN74L00	TIX	0.01	-2	2712.	113.0	24.0	13
SN74L00	TIX	0.01	-2	793.	61.0	13.0	13
SN74L00	TIX	0.01	-2	262.	43.0	6.1	13
SN74L00	TIX	0.01	-2	402.	49.0	8.2	13
SN74L00	TIX	0.01	-2	840.	70.0	12.0	13
SN74L00	TIX	0.01	-2	2014.	106.0	19.0	13
SN74L04	TIX	0.30	1	121.	47.0	3.1	14
SN74L04	TIX	0.30	1	354.	58.0	5.7	14
SN74L04	TIX	0.30	1	263.	63.3	3.9	14
SN74L04	TIX	0.30	1	451.	75.4	5.7	14
SN74L04	TIX	0.30	2	.			
SN74L04	TIX	0.30	2	65.	22.4	2.8	14
SN74L04	TIX	0.30	2	109.	24.4	4.0	14
SN74L04	TIX	0.30	-2	23.	12.1	1.9	14
SN74L04	TIX	0.30	-2	37.	12.7	2.8	14
SN74L04	TIX	0.30	-2	26.	13.0	2.0	14
SN74L04	TIX	0.30	-2	45.	15.1	2.8	14
SN74L04	TIX	0.30	-1	256.	61.9	3.9	14
SN74L04	TIX	0.30	-1	422.	73.0	5.7	14
SN74L04	TIX	0.30	-1	673.	80.3	7.9	14
SN74L04	TIX	0.30	-1	1315.	105.4	11.3	14
SN74L04	TIX	0.03	1	5152.	216.4	23.4	13
SN74L04	TIX	0.03	1	6825.	223.2	29.7	13
SN74L04	TIX	0.03	1	4291.	173.1	22.8	13
SN74L04	TIX	0.03	1	7440.	230.2	30.2	13
SN74L04	TIX	0.03	2	975.	58.5	16.7	13
SN74L04	TIX	0.03	2	2437.	111.7	23.5	13
SN74L04	TIX	0.03	2	923.	53.6	17.2	13
SN74L04	TIX	0.03	2	1937.	86.8	23.3	13
SN74L04	TIX	0.03	-2	258.	30.4	8.0	13
SN74L04	TIX	0.03	-2	154.	22.9	6.2	13
SN74L04	TIX	0.03	-2	225.	26.1	8.0	13
SN74L04	TIX	0.03	-1	894.	136.1	6.4	13
SN74L04	TIX	0.03	-1	673.	126.5	5.2	13
SN74L04	TIX	0.03	-1	1090.	148.1	7.3	13
SN74L04	TIX	0.01	1	10585.	327.3	28.9	13
SN74L04	TIX	0.01	1	14444.	375.0	38.5	13
SN74L04	TIX	0.01	1	11140.	352.1	32.3	13
SN74L04	TIX	0.01	1	18540.	309.0	60.0	13
SN74L04	TIX	0.01	-3	36153.	433.3	89.3	13
SN74L04	TIX	0.01	-3	88483.	752.0	126.9	13
SN74L04	TIX	0.01	-3	33994.	405.0	86.2	13
SN74L04	TIX	0.01	-3	55387.	650.4	107.3	13
SN74L04	TIX	0.01	-2	644.	58.6	11.0	13
SN74L04	TIX	0.01	-2	2254.	98.0	23.0	13
SN74L04	TIX	0.01	-2	550.	50.2	11.0	13

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
SN74L04	TIX	0.01	-2	990.	66.0	15.0	13
LM301A	RSC	1.00	1	24.	11.9	2.0	13
LM301A	RSC	1.00	1	83.	29.4	2.8	13
LM301A	RSC	1.00	1	42.	14.6	2.9	13
LM301A	RSC	1.00	1	177.	39.8	4.1	13
LM301A	RSC	1.00	2	522.	83.7	5.5	13
LM301A	RSC	1.00	2	82.	30.5	2.6	13
LM301A	RSC	1.00	2	228.	65.5	3.8	13
LM301A	RSC	1.00	3	252.	68.3	3.8	13
LM301A	RSC	1.00	3	486.	81.4	5.6	13
LM301A	RSC	1.00	3	121.	44.9	2.5	13
LM301A	RSC	1.00	-3	125.	30.7	3.9	13
LM301A	RSC	1.00	-3	379.	67.5	5.6	13
LM301A	RSC	1.00	-3	64.	22.4	2.6	13
LM301A	RSC	1.00	-3	118.	30.4	4.0	13
LM301A	RSC	1.00	-1	48.	34.9	1.3	13
LM301A	RSC	1.00	-1	49.	74.9	0.7	13
LM301A	RSC	1.00	-1	61.	46.5	1.3	13
LM301A	RSC	0.01	1	1169.	118.8	8.8	13
LM301A	RSC	0.01	1	700.	87.0	8.0	13
LM301A	RSC	0.01	2	7974.	333.9	24.1	13
LM301A	RSC	0.01	2	18159.	494.1	34.5	13
LM301A	RSC	0.01	2	10230.	341.0	30.0	13
LM301A	RSC	0.01	2	19069.	550.7	34.7	13
LM301A	RSC	0.01	3	5400.	300.0	18.0	13
LM301A	RSC	0.01	3	8523.	391.6	21.8	13
LM301A	RSC	0.01	3	4711.	324.9	14.4	13
LM301A	RSC	0.01	3	8876.	410.8	21.8	13
LM301A	RSC	0.01	-3	3680.	230.0	16.0	13
LM301A	RSC	0.01	-3	9100.	350.0	26.0	13
LM301A	RSC	0.01	-3	7150.	325.0	22.0	13
LM301A	RSC	0.01	-3	10500.	375.0	28.0	13
LM301A	RSC	0.01	-2	12100.	402.0	30.0	13
LM301A	RSC	0.01	-2	19200.	482.0	40.0	13
LM301A	RSC	0.01	-2	15800.	394.0	40.0	13
LM301A	RSC	0.01	-2	18320.	458.0	40.0	13
LM301A	RSC	0.01	-1	553.	79.0	7.0	13
LM301A	RSC	0.01	-1	1422.	182.0	7.4	13
LM301A	RSC	0.01	-1	1340.	134.0	10.0	13
LM301A	RSC		1			6.8	13
LM308	RSC	1.00	1	181.	96.5	1.7	13
LM308	RSC	1.00	1	243.	85.1	2.7	13
LM308	RSC	1.00	1	115.	105.7	1.1	13
LM308	RSC	1.00	1	146.	78.4	1.7	13
LM308	RSC	1.00	2	305.	38.3	7.7	13
LM308	RSC	1.00	2	577.	45.5	11.2	13
LM308	RSC	1.00	2	317.	38.8	7.8	13
LM308	RSC	1.00	2	683.	55.1	11.3	13
LM308	RSC	1.00	2	66.	22.5	2.7	13
LM308	RSC	1.00	2	223.	43.2	5.6	13
LM308	RSC	1.00	3	278.	69.9	3.7	13
LM308	RSC	1.00	3	764.	131.2	5.4	13

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
LM308	RSC	1.00	3	469.	82.1	5.5	13
LM308	RSC	1.00	-3	163.	26.4	5.7	13
LM308	RSC	1.00	-3	289.	33.6	8.0	13
LM308	RSC	1.00	-3	237.	26.8	8.0	13
LM308	RSC	1.00	-3	412.	33.4	11.4	13
LM308	RSC	1.00	-1	85.	28.7	2.8	13
LM308	RSC	1.00	-1	163.	36.2	4.2	13
LM308	RSC	1.00	-1	94.	30.2	2.9	13
LM308	RSC	1.00	-1	153.	34.6	4.2	13
LM308	RSC	0.01	1	4800.	300.0	16.0	13
LM308	RSC	0.01	1	4172.	298.0	14.0	13
LM308	RSC	0.01	1	3059.	302.2	10.1	13
LM308	RSC	0.01	2	6486.	266.4	24.9	13
LM308	RSC	0.01	2	11137.	331.4	36.3	13
LM308	RSC	0.01	2	12154.	327.0	35.3	13
LM308	RSC	0.01	2	17528.	387.2	48.3	13
LM308	RSC	0.01	3	3390.	242.0	14.0	13
LM308	RSC	0.01	3	6400.	318.0	20.0	13
LM308	RSC	0.01	3	2700.	300.0	9.0	13
LM308	RSC	0.01	-3	2169.	165.3	12.9	13
LM308	RSC	0.01	-3	3464.	211.2	16.4	13
LM308	RSC	0.01	-3	1591.	143.0	11.1	13
LM308	RSC	0.01	-3	3701.	207.7	17.6	13
LM308	RSC	0.01	-2	12520.	313.0	40.0	13
LM308	RSC	0.01	-2	22740.	379.0	60.0	13
LM308	RSC	0.01	-2	17160.	286.0	60.0	13
LM308	RSC	0.01	-2	23800.	340.0	70.0	13
LM308	RSC	0.01	-1	1817.	202.6	8.7	13
LM308	RSC	0.01	-1	4112.	257.0	16.0	13
LM308	RSC	0.01	-1	1807.	197.1	9.0	13
LM308	RSC	0.01	-1	4760.	280.0	17.0	13
LM311	RSC	0.03	1	3854.	274.0	13.5	13
LM311	RSC	0.03	1	7611.	382.1	19.8	13
LM311	RSC	0.03	1	4399.	297.5	14.2	13
LM311	RSC	0.03	1	7491.	378.5	19.4	13
LM311	RSC	0.03	-1	4038.	285.8	13.6	13
LM311	RSC	0.03	-1	7850.	379.2	20.2	13
LM311	RSC	0.03	-1	3794.	274.7	12.9	13
LM311	RSC	0.03	-1	7199.	369.9	19.2	13
LM311	RSC	0.03	-1	3939.	279.6	13.4	13
LM311	RSC	0.03	-1	7578.	373.4	19.9	13
LM311	RSC	0.03	-1				
LM311	RSC	0.03	-1				
LM311	RSC	0.01	1	909.	286.0	3.1	13
LM311	RSC	0.01	1	981.	301.8	3.2	13
LM311	RSC	0.01	1	1232.	316.5	3.7	13
LM311	RSC	0.01	2				13
LM311	RSC	0.01	2	10000.	250.0	40.0	13
LM311	RSC	0.01	2	6540.	218.0	30.0	13
LM311	RSC	0.01	2	13920.	348.0	40.0	13
LM311	RSC	0.01	3	5575.	223.7	25.0	13
LM311	RSC	0.01	3	17037.	355.0	48.0	13

APPENDIX B

DEVICE	MFG	TIME	PIN	PWR	VAVG	IAVG	SOD
LM311	RSC	0.01	3	7157.	255.6	28.0	13
LM311	RSC	0.01	3	13927.	331.7	42.0	13
LM339	RSC	0.10	1	253.	100.0	2.5	13
LM339	RSC	0.10	1	220.	121.2	1.6	13
LM339	RSC	0.10	1	397.	142.3	2.5	13
LM339	RSC	0.10	2	458.	46.0	8.2	13
LM339	RSC	0.10	2	869.	60.0	12.0	13
LM339	RSC	0.10	2	40[illegible].	57.1	7.0	13
LM339	RSC	0.10	2	80[illegible].	57.7	11.6	13
LM339	RSC	0.10	3	392.	91.1	3.8	13
LM339	RSC	0.10	3	621.	101.9	5.4	13
LM339	RSC	0.10	3	815.	129.1	5.4	13
LM339	RSC	0.10	3	747.	77.0	8.2	13
LM339	RSC	0.10	-3	152.	47.1	2.8	13
LM339	RSC	0.10	-3	288.	61.7	4.0	13
LM339	RSC	0.10	-3	147.	46.2	2.7	13
LM339	RSC	0.10	-2	28.	13.3	1.9	13
LM339	RSC	0.10	-2	47.	13.8	2.9	13
LM339	RSC	0.10	-2	26.	11.4	1.9	13
LM339	RSC	0.10	-2	45.	14.0	2.7	13
LM339	RSC	0.10	-1	364.	78.1	3.9	13
LM339	RSC	0.10	-1	708.	105.6	5.7	13
LM339	RSC	0.10	-1	287.	64.7	3.9	13
LM339	RSC	0.10	-1	533.	78.0	5.8	13
LM339	RSC	0.01	1	935.	187.0	5.0	13
LM339	RSC	0.01	1	2052.	228.6	9.0	13
LM339	RSC	0.01	1	480.	160.0	3.0	13
LM339	RSC	0.01	1	1471.	210.0	7.0	13
LM339	RSC	0.01	2	11556.	321.0	36.0	13
LM339	RSC	0.01	2	12500.	250.0	50.0	13
LM339	RSC	0.01	2	9418.	277.0	34.0	13
LM339	RSC	0.01	2	12628.	308.0	41.0	13
LM339	RSC	0.01	-3	1304.	163.0	8.0	13
LM339	RSC	0.01	-3	1829.	182.9	10.0	13
LM339	RSC	0.01	-3	1914.	174.3	11.0	13
LM339	RSC	0.01	-3	7685.	266.0	29.0	13
LM339	RSC	0.01	-2	245.	51.0	4.8	13
LM339	RSC	0.01	-2	662.	73.6	9.0	13
LM339	RSC	0.01	-2	154.	44.0	3.5	13
LM339	RSC	0.01	-2	401.	61.8	6.5	13
LM339	RSC	0.01	-1	3681.	245.0	15.0	13
LM339	RSC	0.01	-1	6900.	300.0	23.0	13
LM339	RSC	0.01	-1	4032.	252.0	16.0	13
LM339	RSC	0.01	-1	6720.	281.0	24.0	13

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